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THE

NOVUM ORGANON,

OR

A TRUE GUIDE

TO THE INTERPRETATION OF NATURE,

BY

FRANCIS BACON, LORD VERULAM,

LORD CHANCELLOR OF ENGLAND.

A NEW TRANSLATION

BY THE

REV. G. W. KITCHIN, M.A.

STUDENT AND TUTOR OF CHRIST CHURCH, OXFORD.

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EDITOR'S PREFACE.

THERE are only two complete Translations of the Novum Organon already in existence: the first, that given by Dr. Shaw in his Edition of Bacon's Philosophical Works (3 vols. 4to. London, 1733); the other is to be found in Montagu's Edition of Bacon's Works (London, 1831), and was made by Mr. W. Wood.

Dr. Shaw's Edition is extremely rare; Mr. Wood's Translation has been reprinted by Pickering, and is in common use; it also forms, with some corrections, the basis of a Translation published by Bohn. I cannot look on this as anything but a misfortune. Mr. Wood's English is coherent, and reads well; and so long as we read it without referring to the Latin, we believe that, though very obscure, still it must be correct. But the least comparison of the Latin discloses a most extraordinary collection of misapprehensions and mistakes. The worst of these are corrected in Bohn's Edition, but there are radical faults in Mr. Wood's work which lead me to think that it cannot be made the basis of a satisfactory translation.

There is also in existence a Translation of the First Book of the Novum Organon, by Mr. Glassford, printed for private circulation in Edinburgh in 1844. It is consequently hardly to be met with. It is written in a somewhat disagreeable style; the nomenclature is very peculiar; it is not free from errors; and it follows the Latin too closely throughout.

This is the state of the existing translations.

Accordingly, when the Delegates of the Press suggested to me that it would be well to publish the Novum Organon both in Latin and English, I thought it would be the best course to abandon these Versions, and to venture upon a new Translation, which should be accurate, and as clear as the very obscure language of the original would permit. No Translation of Bacon can do justice to his style, or to the forcible language in which his thoughts are conveyed: no author, perhaps, suffers so much under the hand of a Translator. It is a great misfortune that he did not himself leave us an English Version. The subject seems to require to be treated in one of the Modern Languages. Its line of thought, its illustrations and examples, are all modern; and nervous as the Latin is, we are constantly met by unavoidable barbarisms. But Bacon was fonder of turning his English into Latin than the contrary: for he used to say, that "books written in the Modern Tongues must soon become bankrupt,"—an unfortunate Prophecy, as probably nothing has so much hindered the study of the Novum Organon as the difficulty and uncouthness of the Latin in which it is written.

As for my Translation; in point of style, I have tried to copy that of the Advancement of Learning, the only English Work of Bacon which at all resembles the Novum Organon. I have aimed rather at faithful than at elegant rendering; being, as Bacon would himself say, more desirous of Light than of Fruit or Enjoyment. There are several passages as to the interpretation of which I still feel considerable doubt: on these notes will be found upon the Latin Text.

Though in many respects it would be better for the Student first to become acquainted with the Novum Organon through the English, yet the translation cannot stand for the original; and in reading the Work a second time the Latin must be carefully studied.

I have appended to this Volume an entirely new Index, which I trust may be found useful.

Ch. Ch. *March* 14, 1855.

SYNOPSIS.

PREFACE—on the position which the new Method is to hold.

BOOK I.

I. Statement of the object of the Work, Aph. 1—37.

II. The "Pars Destruens," 38—115.

III. The overthrow of Objections preparatory to the Constructive Part of the Work, 116—129.

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  - (i) The scope or object of the Work, more in full, 1—3.
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    - 1. For Human Power, 4.
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      - (α) Latent Process, 6.
      - (β) Latent Structure, 7, 8.
    - Precepts for discovery of Form, 10—52.
      - (1) By example of the Method 10—20.
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ANALYSIS

OF

BACON'S NOVUM ORGANON.

PREFACE.

BACON condemns two opposite extremes, that of the Dogmatists, who extinguish inquiry by affirming that Nature is fully known; and that of the Sceptics, who practically do the same, by affirming that nothing can be known.

The older Greek Philosophers held a middle course, and consulted Nature; thinking, that (as to the question of the possibility of knowledge) it was better to try the matter practically, than to argue on it theoretically.

Bacon's own plan is to start from the senses, putting them in their right place, rejecting the hasty mental operations which ordinarily follow perception, and preparing a new and surer Method.

The need of such a Method the Ancients saw, and tried to make use of Logic as such: but it came too late, and confirmed error rather than discovered truth. Wherefore Bacon proposes to begin afresh, ruling the Intellect by means of proper Instruments.

But though he thus sets aside all the labours of the ancients, he declares himself in no way their antagonist: for both systems, he thinks, can exist together;—the ancient more pleasant, more alluring, because of men's haste, the necessities of civil life, and the weakness of man's intellect; but his own more penetrating, more powerful in subduing Nature, and in giving certainty of knowledge.

The older he terms the *Anticipation of Nature:* his own the *Interpretation of Nature.*

And, finally, he begs men not to give it a merely casual consideration, but to try his Method fairly, accustoming themselves to the subtilty of Nature; correcting and resisting old habits of thought; and then at length passing judgment upon it.................................. page 3—10.

BOOK I.

I. The subject matter of the whole work.

Aph.

1. Human Power, and Human Knowledge. These are limited by man's observation and meditation on Facts. Page 11
2. Neither the hand nor the intellect prosper unaided. Instruments must be had to excite and suggest, or to clear away error. 11
3. Human Knowledge and Power may be considered together. What we predicate as a cause for Knowledge, is also a rule for action. 11, 12
4. The limits of Man's Power are the application or separation of things; the operation resulting is Nature's alone. . 12
5. Alchemists, &c. have failed in production by following only old tracks. 12
6. But new truths are only to be arrived at by the use of new Instruments and Methods. 12
7. All existing truths are the results of a very few Axioms. 12
8. And they are acquired by Chance, not by Art; and so the present Sciences are barren. 12

9, 10. This and all other evils in Science arise from a belief in the power of the Human Mind—whereas Nature's subtilty far exceeds that of the Mind. 12, 13

11. And existing mental culture is bad—Logic gives no help. 13

12. For (α) it only confirms error. . . . . page 13

13. (β) The Syllogism does not profess to touch Prime Axioms, and fails when applied to Mediate Axioms. 13

14—16. (γ) Its Terms are confused; as are also the Conceptions of which they are the expression. . . 13, 14

17. (δ) The Axioms, on which the Syllogism is based, are wrong; both the Prime and the Mediate ones. 14

18. It is clear then that a better Instrument is needed. 14

19. Two ways lie open,

(α) The old Aristotelian Induction, which leapt from particulars to highest generalities.

(β) The new Induction, *per gradus continuos.* 14

20, 21. The ordinary mind follows the former, for the sake of quiet. The better ordered mind tries the latter, but fails for want of regulation and help. 15

22. The two compared. Both begin in particulars and ascend to highest generalities. The former superficially touches on experience. The latter proceeds regularly by means of it. 15

23. Nor is the distinction slight between the Phantoms of the Human Mind, and the Ideas of the Divine. 15

24. The Axioms, too, of the former are useless; of the latter practical. 15, 16

25. Those of the former are got at carelessly; and all contradictory cases are explained away. 16

26. The older process we term *Anticipation of Nature*, the newer, *Interpretation of Nature*. 16

27. The former are firmly established, popular, easy; 16

28. The latter, abstruse, long, hard. 16, 17

29—31. The former do well for dogmatic arguing without appeal to facts; but are of no practical use, as they are radically wrong. And it is in vain to patch up the old with new pieces. 17

32. Therefore we do not try to amend the Ancients; and as we differ entirely in Method, we are quite distinct from, and do not oppose them. .... page 17

33. Nor may our Method be judged by the old. 17

34. It will seem obscure, from the difficulty of explaining an entirely new subject. 18

35. It is not antagonistic to others. It only seeks to enter fit and ready minds. 18

36. We must beg men for a while to abandon preconceptions, and give us an impartial consideration. 18

37. We agree with the Sceptics so far as to say that by the old plan no knowledge of Nature can be obtained; but we differ from them, in that they destroy the evidence of the senses; we try to correct it and provide it with Instruments. 18, 19

II. 38. The truth cannot enter, unless the Phantoms be dispossessed.

39. These are of four kinds, (1) of the Tribe; (2) of the Den or Cave; (3) of the Market-place; (4) of the Theatre. 19

40. These must be pointed out separately; and this part of the Novum Organon will answer to the Soph. Elench. of the old Logic. 19

41—44. The four Phantoms shortly described. 19, 23

45. (1) ***Phantoms of the Tribe.*** Of the whole race of man.

Arising :—

45. (a) From the spirit of system innate in us. 21, 22

46. (b) From the clinging to preconceived notions. 22, 23

47. (c) From the narrowness of the human mind. 23

48. (d) From its restlessness. 23, 24

49. (e) From the influence of the senses. 24

50. (f) From the stupor and errors of the senses. 25

51. (g) From the manner of impression............. 25

52. Recapitulation of the above seven causes.......... 26

53. (2) *Phantoms of the Den*. Of each individual mind. These arise :— .... page 26
54. (a) From the keen love of some one subject. 26
55. (b) From the two extremes of observing either resemblances only or differences only. 27
56. (c) From too great an admiration of either antiquity or novelty. 27
57. (d) From regarding objects out of all proper proportion to one another. 28
58. Recapitulation of the above four causes. 28

59. (3) *Phantoms of the Market-place*. Those of man's intercourse, viz. his language. 29
60. These are of two kinds, either (a) Actual error in apprehension, so affirming the non-existent to be existent—or (b) Indistinctness of Apprehension. 29

61. (4) *Phantoms of the Theatre*. Of different Philosophical Systems. Divided under three great heads. (a) The divisions of these Schools. (b) The external signs of faultiness in them. (c) The causes of this unfortunate continuance in error, and of its prevalence. 31
62. (a) (i) The faulty Philosophical schools may be divided into, ... 32
63. (α) The Sophistical—at the head of which is Aristotle. 34
64. (β) The Empiric—of which Gilbert is a good example. 35
65. (γ) The Superstitious—as those of Pythagoras and Plato. 36
66. (ii) The subject matter of these Theories also erroneous.
    (α) From arguing from Mechanics to the Universe.
    (β) Or from the Liberty of Nature and the different species of things to abstract Platonic Ideas.
    (γ) But specially that men regard the origins *ex quibus*, rather than the means *per quæ*, things

are done—whereas all real benefits are to come from the study of means. .. page 37

67. (iii) And a caution must be added against the two extremes of Dogmatism and Scepticism. 41

69. (iv) As also against the faulty kinds of demonstration in vogue.
  (α) Not only Deduction,
  (β) But Ancient Induction also is faulty.
    1. Because the Impressions of the senses are vicious.
    2. Because the notions abstracted thence are bad,
    3. Because of the ordinary process "*per enumerationem simplicem.*"
    4. Because of the leaping from particulars to summa Genera. 42

70. (v) The best kind of Proof is Experience; and here too are faults.
  (α) From want of Method.
  (β) From insufficient Variation.
  (γ) From the following of one experiment only.
  (δ) From haste to reach practical application. 45

71. (b) The external signs of false systems, seen,
  (i) In their origin.
    (α) Place and Person. 47
72. (β) Time and Age. 48
73. (ii) In their Fruits. 48
74. (iii) In their want of Progress. 49
75. (iv) In the confessions of their Authors. 50
76. (v) In their disagreement. 51
77. (vi) In the late general consent in Aristotle. .. 52

78. (c) The causes of Error and Failure are,
  (i) The narrow limits of Philosophical Periods,
    (α) The Greek—about two centuries.
    (β) The Roman—ditto.
    (γ) The European—ditto. 52

79. (ii) The neglect of Natural Philosophy. page 55
80. (iii) The fact that Natural Science rarely gets full possession of a man's mind. 56
81. (iv) The want of definite ends in the Sciences. 57
82. (v) The errors in men's use of means. 58
83. (vi) The contempt for particulars. 60
84. (vii) The too great reverence for Antiquity. .. 61
85. (viii) The exaggerated admiration at the present skill of men,
    (α) In Mechanical Arts.
    (β) In Liberal Arts.
    (γ) In Books.
    (δ) In Alchemy, &c.
    (ε) In Natural and Superstitious Magic. 62
86. (ix) The tricks of those who have treated of Science. 66
87. (x) The levity of those who have set forth new systems. 66
88. (xi) The want of energy to grapple with difficulties. 68
89. (xii) Superstition and blind zeal. 70
90. (xiii) The customs of Schools and Colleges. .. 73
91. (xiv) The absence of rewards for these studies. 74
92. (xv) The despair of men. 74
This last leads Bacon to point out

Grounds of Hope.

93. (1) From the favour of God. 76
94. (2) From the previous errors of men: for if these be removed, there is a far better chance for knowledge. 77
95. These errors are,
    1. The Empiric or Dogmatic systems. 78
96. 2. The intermixture of extraneous matter. 78
97. 3. The trammels which tie down all thinkers. 79

98. 4. The badness of the foundation on which experiment has hitherto stood. .... page 80

99. 5. The desire for immediate gain or reward. 81

100. 6. The want of some fixed rule in experiment. 82

(3) These lead Bacon to point out the great advantages possessed by his own system when compared with the older.

1. It has a definite rule. 82

101, 102. 2. It uses "literate experience" collected into Tables. 82

103, 104. 3. It seeks for Axioms, and not immediate results; and Intermediate, not Prime Axioms. ... 83

105. 4. And this by means of a better system of Induction, which proceeds from negative to affirmative. 85

106. 5. It duly tests the Axioms obtained. 85

108. (4) Some things were discovered even under the old system—no need therefore to despair of discoveries under the new. 86

109. And some of these are things which would not have been guessed—such as Gunpowder, Silk, the Compass. 89

110. And others, which ought to have been hit on readily, lay hid under men's eyes—which shews that the old system passed by things quite within its reach, as e. g. Printing. 98

111. (5) Hope from the great labour men are willing to undertake on subjects of but little use. 90

112. (6) Hope from the better chance the new system has of mastering the infinitude of particulars. 91

113. (7) Hope from Bacon's own example. 91

114. (8) Lastly; a gallant man would make the attempt with far less hope than is presented here. 92

115. This ends the *Pars Destruens*. 92

III. Now follow preparatory remarks, opening the way for the Constructive part, by clearing away objections and doubts

116. (1) Men might think this a setting up of new Sects,—not so; it is Bacon's object simply to try to lay better foundations for, and to extend more widely the authority and power of Man. . . . . . . page 94

117. (2) Men might say that samples of the results of this system should be shewn. But this will follow in time. 95

118. (3) Men might urge that the Tables contain errors;—such things must happen at starting, but do not vitiate the system; the false will in due time be ejected by the system itself. 96

119. (4) No objection is to be urged from the use

(α) Of ordinary subjects. 97

120. (β) Of vile and mean instances. 98

121. (γ) Of curious and subtle matters. 99

122. (5) Men might urge that this new Method sweeps off all the old Philosophies, and uses no authorities. But it appeals to *facts*, not to *authorities*; it would be far less modest if it judged and blamed some and not others; as it is, it lets the old remain untouched and follows its own line, hitherto entirely neglected. 101

123. (6) Nor is there any conceit in it, as it has a tendency to level all Intellects. 103

124. (7) There is nothing in the objection, that our end is not so true and high as it should be. For we do aim at the real Ideas of the Divine Mind; and have for our end those highest things Truth and Usefulness. 104

125. (8) The objection that this Method was known to and practised by the Ancients is nothing. For their Induction was entirely different from this. 104

126. (9) The objection that this plan leads to scepticism is denied: for it leads to a right valuation and regulation of the evidence of the senses. . . . . page 106

127. (10) It might be objected (or, rather, asked) whether this system does not exclude Moral and other Sciences. It does not, for it is an Instrument which may be applied to many different subjects, just as the old syllogism was. 106

128. (11) Men might object that it tends to destroy the existing Arts, &c. But the Method does not in any way interfere with them; and Bacon has already given his opinion as to their worth in the "Advancement of Learning." 107

129. Finally, Bacon adds a few words on the excellence of his aim. . . . . 108—111

(α) The bringing in of noble Inventions is glorious.
(β) Inventions are like new creations.
(γ) Their excellence is seen in the superiority of civilised lands.
(δ) Their consequences are weighty.
(ε) The ambition of discovery is most noble.
(ζ) And the uses of this end are manifold.

Nor finally should objection be taken from its abuse.

130. We are now ready to pass on to the Constructive part. 111, 112

BOOK II.

The scope of our desires :—viz. the objects of Human Power and Human Knowledge.

Aph. Page 113

1. (1) The generation of new Natures.
(2) The discovery of Forms.
Subordinate to (1) is the transformation of concrete bodies;
to (2) is the discovery of (α) Latent Process and (β) Latent Structure.

2. Knowledge is the insight into things by their causes. 114
These are ordinarily four :—(i) Material; (ii) Formal; (iii) Efficient; (iv) Final.
Of these the second, *Form*, is the object of Bacon's researches.

3. As men now are, both Knowledge and Power are imperfect. 115
(1) Our Knowledge is only of partial cases.
(2) Our Power is only over some materials.
(3) Our Knowledge is of Matter and Efficient only.
(4) The true Knowledge and Power will be attained only by Knowledge of Forms.

4. The ways to both Knowledge and Power are almost identical. 115
(1) Bacon subjoins some practical rules for Human Power.
Our means must be (i) Certain; (ii) Easy; (iii) Easier than the result.

5. Subordinate to this will be practical rules for the transformation of bodies. . . . . page 117
    (*a*) By regarding them as aggregates of simple Natures (so requiring previous Analysis).
    (*β*) As concretes, as they are found in Nature, (so requiring some knowledge of Latent Process.)

6. (2) Bacon next takes the discussion of the subordinates to *Form*. 120
    (*a*) What Latent Process is.
7. (*β*) What Latent Structure is. 121
8. He guards against the opinion that this leads to an Epicurean and Atomic Theory. 123
9. He divides off certain scientific terms. 124
    (*a*) Discovery of *Form* will be Metaphysics.
    (*b*) Inquiry into Efficient and Material causes, Latent Process, and Latent Structure, will be Physics.
    To (*a*) is subordinate (in a new sense) Magic.
    To (*b*). . . . . Mechanics.

10. (3) Now follow Rules for the discovery of Truth: i. e. of *Forms*—the grand object of the book. 124
    The Interpretation of Nature is in two parts.
        1. Discovery of Axioms by experience.
        2. Application of Axioms to new experience.
    The Novum Organon regards only a part of 1. which is divisible under three heads.
        (1) Ministrations to the Senses.
        (2) . . . . to the Memory.
        (3) . . . . to the Mind.
    The means for (1) is Preparation of a Natural History.
        For (2) Construction of Tables.
        For (3) the Application of true Induction.
    And we must begin at the end, and proceed backwards.

11. To begin then with the Mind. 125
    We must make three Collections of Instances (only speci-

mens of the second Ministration) on each subject. Bacon chooses Heat as an illustration.

(1) Collection of Instances agreeing in the given Nature of Heat;—(Table of Essence and Presence;) —of this twenty-seven kinds are enumerated.

12. (2) Collection of Negative Instances—cases of absence of Heat —subjoined to Collection (1) in due order. page 128

13. (3) Collection of Cases giving Comparison, (Table of Degrees.) 140

14. Subjoined is an apology for the imperfection of these Collections, arising from the want of the first Ministration. 149

15. Induction proper now comes into play, resulting in the Discovery of Forms, which are once more described. 149

16. With a view to this discovery, separation or rejection must take place, before the affirmative part can be reached. 150

17. But care must first be taken, lest we confuse our object by mistaking the true Form for either 151

α. Copulate Forms, or conjunctions of Simple Natures; or
β. Platonic or Ideal Forms.

18. There is now added a fourth Collection or Table of Exclusions; 153

19. With some apologetic remarks on its defects. 155

20. And finally comes the *First Vintage* of the Form of Heat. Its Genus is *Motion* (and certain cautions are added as to the equivocal use of the term). It is limited by four differences. 155

(1) It is *expansive* Motion.
(2) It is Motion *which has an upward tendency.*
(3) Its expansion is *infinitesimal, through the particles of the body, and restrained.*
(4) It is *rapid.*

And finally the Definition (or Form) is stated

α. With a view to Knowledge;
β. . . . . Power.

21. Having thus illustrated this *First Vintage*, Bacon now proceeds to the rest of the Mental aids; which are nine in number, but of which the first only is drawn out. p. 164

22. This first is called the collection of Prerogative Instances, i. e. of those Instances which have the greatest influence on our discovery of Truth........................ 164

(1) Those which address themselves to the Understanding. These are 1—15.

1. Solitary Instances. 164
23. 2. Migrating. 166
24. 3. Ostensive............................ 168
25. 4. Clandestine. 170
26. 5. Constitutive......................... 173
27. 6. Conformable.......................... 177
28. 7. Singular. 183
29. 8. Deviating............................ 184
30. 9. Frontier. 185
31. 10. Of Power............................ 186

32. Instances 6—10 are to be gathered from the very outset of our Physical Inquiries.................... 190

33. 11. Accompanying and Hostile. 191
34. 12. Subjunctive (to 11).................. 193
35. 13. Of Alliance. 194
36. 14. Crucial.............................. 201
37. 15. Of Divorce. 217

(2) Those which assist the Senses, entitled generally,
38. Instances of the Lamp. These are 16—20. 220

39. 16. Of the Door......................... 220
40. 17. Citing. 223
41. 18. Of the Way. 234
42. 19. Supplementary....................... 236
43. 20. Probing. 239

(3) Those which tend to Practice. These are 21—27.

44. Practice fails (*a*) because of errors, which chiefly arise from a want of due limiting and measurement of bodies as to strength, &c. page 240

(*β*) because it is usually too toilsome.

Against (*a*) we have four Instances, viz.

45. 21. Of the Measuring Rod. 242
46. 22. Of the Course. 247
47. 23. Doses of Nature—Instances of "How much." 252
48. 24. Of the Struggle—which introduce Bacon's nineteen kinds of Motus. 254

Against (*β*) we have three Instances.

49. 25. Intimating. 283
50. 26. Of Many Uses. 283
51. 27. Magical. 302

52. A short summary of them, and of their applications, with a conclusion, which is also a preface to the remaining eight parts of the Ministration to the Intellect. . . . . 303—306

Translation of that part of the Distributio Operis (*the outline of the "Instauratio Magna"*) *which relates to the Novum Organon.*

"Now that we have coasted past the Ancient Arts (i. e. in the first Part, the "Partitiones Scientiarum"), we will prepare the human Intellect for its passage to new lands of discovery. And so this second Part has for its end Instruction as to a better and more perfect use of Reason in discovery of things, and the true aids of the Intellect: so that (as far as the frail condition of humanity allows) the Intellect may be raised by it, and enabled to scale the steep and dark ascents of Nature. This Art (which we term *the Interpretation of Nature*) is in kind Logical; although between it and ordinary Logic there is a vast, immeasurable difference. For the latter does indeed also profess to elaborate and provide help and guards for the Intellect; and so far only we agree. But ours differs from it chiefly in three ways: viz. (1) in its end; (2) in the order of its demonstrations; and (3) in the starting point of its inquiries.

"(1) For the end proposed for this Science of ours is the discovery not of Arguments, but of Arts; not of what agrees with Principles, but of Principles themselves; not probable reasons, but the marking out and indication of effects to follow. And so, the intention of each being different, different results ensue in each. There the adversary is vanquished and bound down by Disputation; here* Nature by Operation.

"(2) And to an end of this kind correspond both the nature and the order of our Demonstrations. For in common Logic almost all men's labour is expended on the Syllogism. As to Induction, Logicians scarcely seem to have thought seriously about it; passing it over with but light notice, and hastening on to formulæ of Disputation. But we reject Syllogistic Demonstration, because it acts confusedly, and lets Nature slip out of its hands. For although no one can doubt that "quæ in medio termino conveniunt, ea et inter se conveniunt"—(for this has a sort of Mathematical certainty), yet there lies under it the fallacy, that the Syllogism is composed of Propositions, Propositions of words, words are the counters and signs of conceptions. And so if the conceptions of the mind (which are as it were the soul of words, and the basis of all this structure and fabric) be badly and carelessly abstracted from things, be vague, ill defined and circumscribed, and faulty in many ways, the whole thing falls to the ground. And so we reject the Syllogism; and that, too, not only for first Principles (to which Logicians themselves do not apply it), but also for middle Propositions; which Syllogism indeed produces and brings forth; but which are barren of products, remote from practice, and clearly useless for the active part of the Sciences. Accordingly, although we leave to Syllogism, and such-like famous and boasted kinds of Demonstration, jurisdiction over popular Arts, and those which depend on opinion (for we make no movement in this direction), yet for the Nature of things we make use of Induction throughout, and for minor as well as for major Propositions. For we count *Induction* to be that form of Demonstration which defends the Senses, presses on Nature, and is close to, and almost takes part in, production of results.

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* In the Ed. 1620 the word *Naturâ* is marked as an ablative. If it were nominative, the sense would be better: as it would then stand over against *adversarius*.

"And so the order of Demonstration is also entirely inverted. Hitherto things have been carried on as follows:—men fly from the Senses and particulars direct to most general axioms, as to fixed poles round which disputations turn; and from these everything else is derived by means of middle terms: a short way, certainly, but precipitous; one which Nature cannot tread, though easy and smooth for Disputations. But by our plan, Axioms are brought out continuously, step by step, so that one does not reach the most general Axioms till the last: but these when reached are not conceptional, but well limited; and such as Nature acknowledges as really more noscible to herself, and such as reach to the very marrow of things.

"Moreover in the form of Induction, and the judgment which takes place by it, we undertake far the greatest matter of all. For that Induction of which Logicians speak, which proceeds by Simple Enumeration, is a puerile matter, concludes uncertainly, is exposed to danger from a single Contradictory Instance, and only looks into subjects to which we are accustomed; nor does it discover the end.

"But for the Science of Induction there is need of a form which may solve experience, may separate things, and, by means of due exclusions and rejections, conclude necessarily. But if that common Judgment of the Logicians is so weighty, and has exercised such great minds,—how much more should we toil over this kind, which is drawn not only from the reason of the Mind, but even from the very bowels of Nature.

"(3) Nor is the end here. For we also press down more tightly, and make solid the foundations of the Sciences, and take a lower point for beginning inquiry than men have done hitherto: by subjecting those things to test, which common Logic receives on trust. For the Logicians borrow the principles of each Science from that Science in particular: then worship the first conceptions of the Mind: lastly, are quite satisfied and rest in the immediate information of the Senses: but we have determined that the true Logic ought to enter the province of each Science with greater Authority than the principles of each possess; and to make those same imaginary principles render an account of their real value. As to the first conceptions of the Intellect, none of those things which the Intellect gathers when left to itself is other than suspected by us, and we do not ratify it, unless, after new judgment, it stands and is pronounced valid. Moreover, we try the information of the Senses also in many ways. For the Senses are also fallacious, but shew their mistakes. The mistakes are near at hand, but helps against them are sought from afar.

"The faults of the Senses are two: they either fail or deceive. For in the first place there are a multitude of things which escape the Senses even when they are rightly disposed and nohow hindered; either by the subtilty of their whole body, or by the minuteness of their parts, or by their distance, or by the slowness and even the swiftness of their motion, or by the familiarity of the object, or other reasons. And again, where the Senses lay hold of a thing, their grasp is not particularly firm. For the testimony and information of the Senses always are measured by Man, and not by the Universe: and it is a great mistake to assert, that Sense is the measure of all things.

"And so to meet these evils we, with much and faithful service, have sought out and gathered helps for the Senses from every side; so to supply substitutions where they fail, rectifications where they vary. Nor do we attempt this with Instruments so much as with Experiments. For their subtilty is far greater than that of the Senses, even when aided by exquisite instruments. And so we do not allow much to the immediate and proper perception of the Senses: but make the Senses judge only of Experiments, Experiments of things."

So Bacon claims to be the real defender and interpreter of the Senses. And this would be sufficient, were men's minds clear from false prepossessions; but this is unfortunately not so.

Men's minds are filled by a garrison of Phantoms; these are either *Adscititious* or *Innate*. The former have come in from the Philosophers, or from false logical demonstrations. The latter are inherent in the Nature of the Intellect itself. Of these the former may with much pains be driven out, the latter are hopeless. This purification of the Intellect is carried on by three *Redargutiones*:—the confutation of Philosophical Systems; of Demonstrations; and of Native Human Reason.

And Bacon ends thus, "And when we have cleared these points, and made it plain what is the Nature of Things, and what that of the Mind, then we think we shall have prepared and decked the marriage bed for the Mind and the Universe, under the eye of the Divine Goodness. Let the Prayer of our Bridal song be, that from this marriage may spring aids for mankind, and progeny of Inventions, which shall overcome, to some extent, and subdue our needs and miseries."

THE

NOVUM ORGANON,

BY

FRANCIS BACON, LORD VERULAM.

TO THE

MOST SERENE AND MIGHTY OUR PRINCE AND LORD

JAMES,

BY THE GRACE OF GOD, KING OF GREAT BRITAIN, FRANCE,
AND IRELAND, DEFENDER OF THE FAITH, &c.

Most serene and mighty King,

YOUR MAJESTY may perhaps accuse me of theft, for having stolen from your affairs so much time as was requisite for the accompanying Work. I have no plea to make. For Time cannot be restored; unless perchance the time taken from your concerns can be repaid in the memory of your Name, and the honour of your Age; if indeed these writings of mine be of any worth Novelty they certainly have, and that too not in degree only, but in kind; and yet they are copied from sources of sufficient antiquity—the Universe itself, and the nature of things and of the human mind. And let me honestly confess it, I myself certainly am wont to consider this Work rather as the offspring of Time, than of Intellect; for the only marvel in it is, that to begin this matter, and to suspect the established order of things, should have entered into any man's mind. For everything else follows readily enough. But doubtless Chance (as we call it) and something like Fortune affect what men think, as much as what they do or say. And as to this Chance, of which I am speaking, I wish it to be understood, that if there be aught good in what I produce, it is to be attributed to the vast mercy and goodness of God, and to the happy auspices of your times. Throughout my life I have served your Majesty with most unbroken care, and when dead, I shall perhaps have achieved so much, that these times, thanks to the torch thus lit in dark shades of Philosophy, shall shine exceeding bright before Posterity.

Rightly indeed is this *Regeneration*, this *Instauration* of the Sciences due to the times of that king who is most wise, most learned of all.

And now I have but one petition to make, one not unworthy of your Majesty—one which bears most especially on the matter in hand. It is this. I pray you that as you remind every one of Solomon by the weight and justice of your decisions, by the peacefulness of your reign, by the openness of your heart, by the noble variety of the books you have composed, so you will also (following still the example of the same king) see to the perfect collection of a Natural and Experimental History, true, severe, and without philological questions—one which may be a means for the building up of Philosophy, one, in fact, such as we shall describe in its right place; that so, after these many ages of the world, Philosophy and the Sciences may no longer be floating and light, but may rest on the solid foundations of an experience both universal and carefully weighed and examined. I, for my part, provide an Instrument—from things themselves are the materials to be obtained on which it is to work.

May God long preserve your Majesty in health and wealth.

Your Majesty's
most attached and devoted servant,
FRANCIS VERULAM,
Chancellor.

NOVUM ORGANON,

OR

A TRUE GUIDE

TO THE

INTERPRETATION OF NATURE.

PREFACE.

THEY who have dared to pronounce on Nature, as on a thing thoroughly explored, whether they have done it through self-confidence, or from ambition and in a dogmatic manner, these men have done the greatest damage to philosophy and the sciences. For in proportion as they have gained credit, they have succeeded in extinguishing and destroying inquiry; and their own excellence has done less good than their corrupting and ruining the excellence of others has done harm.

On the other hand, they who have followed the contrary course, and have asserted that nothing at all can be known, whether they have fallen into this opinion from hatred of the old Sophists, or from uncertainty of mind, or even from some plenty of learning, these certainly have put forward no despicable reasons for their doctrine. Nevertheless, they have not derived their opinion from true sources, and, carried on by a kind of zeal and affectation, have utterly passed all bounds.

But the older Greeks, whose writings have perished, held their course more prudently between the vain-glory of Dogmatism and the despair of Scepticism; and though they were wont often to complain and grow indignant at the difficulties of inquiry and the obscurity of things, though thus gnashing the bit in their impatience, they have yet not ceased to press their point, and to employ themselves upon Nature: for they thought it fitting, as it seems, not to argue the question as to whether any thing can be known, but to make trial of the fact. But even these used only the powers of intellect, without any application of rule, and made all depend on earnest meditation and perpetual exercise of mind and reflection.

Now our plan is as easy to explain as it is hard to carry out. It consists in laying down grades of certainty, in defending the senses by reducing them to their proper functions, in rejecting for the most part that operation of the mind which follows directly after the operation of the senses; and then in opening and laying down for the mind a new and certain way from the perceptions of the senses. And this, undoubtedly, they also saw who assigned such important functions to Dialectics; and it is clear they sought for some support for the intellect, while they suspected the native and spontaneously acting process of the mind. This remedy, however, came altogether too late; for things were desperate, after that the mind, thanks to the daily habits of life, was both filled by polluted discourse and teaching, and possessed by vainest phantoms. And so that Art of Dialectics taking heed to this too late, and nohow restoring the matter, was potent rather for the confirmation of errors than for the disclosing of Truth. There remains but one hope for safety and health—in the entire recommencement of the whole work of the mind; and in nohow leaving the mind to itself from the very beginning, but in perpetually guiding it, and in carrying out our object as it were by means of machinery. For truly if men had attempted works which required mechanical means with their bare hands, without the power and aid of instruments, as they have not hesitated to handle intellectual work with little but the bare strength of their minds, very small would have been those things which they would have been able to move and overcome, even though they had exerted strenuous and combined efforts. And let us linger a moment, and look into this same example, as into a mirror; let us suppose the question to be, how perchance some obelisk of remarkable size could be moved from one place to another, to grace some triumph or such-like pageant—would not any sober spectator of the proceeding declare it an act of great madness, were men to attempt it with their bare hands? Suppose they were to increase the number of hands employed, and so trust that

start over

they might prevail—would he not say it was only so much the more an act of madness? And then if they were to make some selection, exclude the weaker, use only the robust and vigorous, and hope that so at any rate they might compass their object, would not the spectator say they were only worse and worse? And if, moreover, not content even with this, they were at length to determine to consult the Athletic art, and then were to order their workmen to appear with hands, arms, and muscles duly oiled and prepared, would not the spectator now cry out that they were endeavouring to be mad with some method and consideration? And yet men are borne along with with a like unsound energy and useless combination in matters intellectual, so long as they hope for great results either from the multitude and consent, or from the excellence and acumen of intellects, or even while they brace up the muscles of their minds with Dialectics, which may truly be regarded as a sort of mental gymnastics: but meanwhile, although they use so great diligence and endeavour, yet (if one rightly judges) they cease not to apply only their bare intellect. But it is most clear, that, in every great work which men's hands produce, neither the strength of individuals nor of numbers can be combined without the application of instruments and machines.

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And so having premised so much, we lay it down that there are two points on which, for fear they should escape notice and regard, we desire to warn mankind. Of these the first is this. Thanks to the kindness of Fate (as we count it,) with a view to the extinction and expulsion of contradiction and irritation, the honour and reverence due to the ancients remains untouched and undiminished, while still we can perfect our projected work, and reap the fruit of our moderation. For had we professed that we produced something better than the ancients in their own line of proceeding, by no skill of words could we have avoided the introduction of some comparison or contention of wit or excellence or powers; and this though neither unlawful nor a novelty, (for why should we not, in our own right,—which is just the same with the right of every one else—blame or point out whatever is wrongly invented or assumed among them?)—this, however just it were and allowable, yet would perchance be an unequal match for us, by reason of the disproportion of our strength. But when this is our object—to open for the intellect an entirely new way, untried by them, unknown to them, then the case is altered; their party feelings cease; and we sustain only the character of a guide—one surely, only of small authority, and perhaps rather one of good fortune than of power and excellence. This first warning points to persons, the second will refer to the subject matter.

Now we do not endeavour in the least to disturb that Philosophy which is now flourishing, nor any other that may be now or hereafter more correct or more extensive than it. For we will not hinder the received Philosophy, and others of the same kind, from nurturing disputations, adorning discourses, being useful and authoritative for the duties of the Professorial chair or the despatch of civil affairs. Nay more, we openly testify and declare that this Philosophy which we are bringing in will not be very useful for these objects. For it is not ready at hand; it is not apprehended cursorily; it flatters not the intellect by preconceived notions; it will not descend into the grasp of the vulgar, except through its utility and its effects.

And so let there be (and may each party have every blessing and happiness therein) two sources, two Distributions of Learning; and similarly two tribes, and, as it were, two kindred races of contemplators and philosophers: and let these be in no way hostile and estranged from one another, but joined in alliance of mutual assistance; in a word, let there be one way of cultivating the Sciences, another of discovering them. And we pray that they who find the former the more pleasant and acceptable on account of their eagerness, or the requirements of civil life, or because through infirmity of mind they cannot understand and embrace the second, (which must necessarily happen to far the greatest number of men,) may succeed happily and as they desire in what they undertake, and attain to that which they pursue. If, furthermore, any man desire and care not merely to cling to discovery and make use of it, but to penetrate beyond; and to overcome, not an adversary in disputation, but Nature in production; if finally he desires not to produce fine probabilities, but certain and demonstrative knowledge; let him, as a true son of the Sciences, join himself to us if it shall seem good to him; that so, on his having left the outer courts of Nature, which numbers infinite have trodden, there may be opened to him at last an approach to her secret chambers. And that we may be the better understood, and that what we mean may appear more familiarly through the giving definite names; we are wont to call the one system or method *the Anticipation of Nature*, and the other, *the Interpretation of Nature.*

We seem to have yet one request to make. At any rate we have taken much care and consideration in order that what we propose shall not only be true, but also may be able to reach without much difficulty or harshness the minds of men, although they are in a wonderful way prepossessed and narrowed. Still we may fairly require this of men, especially in so great a restoration of Learning and Sciences, that whoever wishes to determine or think about this work of ours, influenced by his own sense, or by the crowd of authorities or by the formularies of demonstration, (which have nowadays become as authoritative as legal rules,) should not hope to be able to do so cursorily or in the midst of other business; but should get a thorough insight into the matter; should himself gradually try this way of ours which we mark out and make; should accustom himself to the subtilty of things which is manifested by experience; and finally should correct, by seasonable and as it were legitimate hesitation, the faulty and deeply fixed habits of the mind; and then, at last, if it should please him, when he has begun to be his own master, let him use his own judgment.

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APHORISMS

ON

THE INTERPRETATION OF NATURE

AND

THE REALM OF MAN.

BOOK THE FIRST.

1. MAN, the minister and interpreter of Nature, does and understands so much as he may have discerned concerning the order of Nature by observing or by meditating on facts: he knows no more, he can do no more.

2. Neither the bare hand nor the intellect left to itself have much power; results are produced by instruments and helps; which are needed as much for the understanding as for the hand. And as instruments of use to the hand either rouse or regulate its movements, so instruments for the mind either prompt the intellect or defend it from error.

3. Human knowledge and power coincide, because ignorance of the cause hinders the production of the

effect. For Nature is not conquered save by obedience: and what in contemplation stands as a cause, the same in operation stands as a rule.

4. With a view to results man can do nothing but apply and remove natural bodies: everything else Nature performs within.

5. The Mechanician, the Mathematician, the Physician, the Alchemist, and the Magician are wont to interfere with Nature (as far as regards results): but all, as things now stand, with slight endeavours and small success.

6. It is madness, and a downright contradiction, to think that those things which never have been done as yet, can be done except by means never as yet tried.

7. The productions of mind and hand seem numerous enough in books and manufactures. But all that variety consists in a wonderful subtilty, and in subdivisions of a few well-known things; but not in a number of axioms.

8. Even the results which have been already discovered are due to Chance and Experience rather than to the Sciences: for those Sciences which we now have are nothing more than certain refinements on things previously discovered; not methods of discovery or plans for obtaining new results.

9. The cause, however, and root of almost all evils in the Sciences is this one; that while we falsely admire and exalt the powers of the human mind, we do not seek its true aids.

10. The subtilty of Nature far surpasses the subtilty

of sense and intellect; so that men's fair meditations, speculations and reasonings are a kind of insanity, only there is no one standing by to notice it.

11. Just as the Sciences which now prevail are useless for the discovery of results, so the Logic also which now prevails is useless for the discovery of Sciences.

12. The Logic which is in vogue is rather potent for the confirming and fixing errors (which are based on vulgar opinions) than for the investigation of Truth: so that it is more harmful than useful.

7 13. The Syllogism is not applied at all to the principles of Science—is applied in vain to the medial axioms, since it is no match for the subtilty of Nature. And so it constrains Assent, not Things.

7. 14. Syllogism is composed of propositions, propositions of words, words are the symbols of conceptions. And so if the conceptions themselves (which are the foundation of the whole thing) be confused and rashly abstracted from things, there is no solidity in what is built upon them. And so our only hope is in a true Induction.

15. In the conceptions both of Logic and Physics there is nothing sound: our conceptions of *substance*, *quality*, *action*, *passion*—and even of *being*—are not good; much less those of *weight*, *levity*, *density*, *rarity*, *moisture*, *dryness*, *generation*, *corruption*, *attraction*, *repulsion*, *element*, *matter*, *form*, and the like—all of them are fanciful and ill-defined.

16. The conceptions of *Infimæ Species*, *man*, *dog*, *dove*, and of the immediate apprehensions of the

senses, *warm*, *cold*, *white*, *black*, do not so very much mislead; and yet even these are sometimes confounded from the flux of matter and the strife of things—All other conceptions~~, which mankind~~ have used up to ~~this time, are errors,~~ and abstracted and drawn out of things by no due methods.

17. And there is just as much license and error in making axioms as there is in abstracting conceptions; and that too even in those first principles which depend on the ordinary Induction. But this is still more the case in the inferior axioms and propositions which Syllogism evokes.

18. What things have been hitherto discovered in the Sciences are of such a kind as to be subjects of common conceptions; but in order that we may penetrate to the inner and more remote secrets of Nature, it is necessary that conceptions as well as axioms should be abstracted from things by a more certain and a better made way, and that a thoroughly improved and more certain method of applying the Intellect should be brought into use.

→ 19. There are and can be but two ways of investigating and discovering Truth. The one leaps from the ~~senses and~~ particulars to the most general axioms, and from these as first principles, and their unshaken truth, judges on and discovers medial axioms: and this way is in vogue. The other raises axioms from the senses and particulars, by ascending steadily, step by step, so that at last the most general may be reached; and this way is the true one, but untried.

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20. The Intellect, if left to itself, follows the same way, (i. e. the former,) which it adopts according to the order of Logic. For the mind delights to leap forth to things more general, that it may rest: and after a short delay disdains Experience. But these evils are after all augmented by Logic, by reason of displays of disputation.

21. The Intellect, if left to itself, in a sober, patient and grave disposition, (especially if it be not hindered by received doctrines,) tries somewhat that second and right way, but with only slight results; since the Intellect, unless it be ruled and helped, is unequal to and utterly unfit to overcome the obscurity of things.

22. Both ways begin from the senses and particulars, and rest in the most general propositions: but there is a vast difference between them; since the former only touches cursorily on experience and particulars, while the other is rightly and duly engaged upon them; the former again from the very beginning lays down some abstract useless generalities; the latter rises step by step to those things which are truly in Nature more noscible.

23. There is no slight difference between the Phantoms of the human mind and the Ideas of the Divine mind, that is, between mere idle and arbitrary views, and the true signatures and impresses made on things created, as we find them.

24. It cannot possibly be, that axioms established by means of reasoning should be of any value for the discovery of new results; because the

subtilty of Nature far exceeds the subtilty of reasoning. But axioms duly and orderly abstracted from particulars in their turn easily point out and mark off new particulars; and so render the Sciences active.

25. The axioms now in use have sprung from a slender and unassisted experience, and those few particulars, which most frequently occur, and for the most part are made and stretched according to the measure of these; and so no marvel that they do not lead to new particulars. And if perchance any instance, not before observed or known, offer itself, the axiom is saved by some frivolous distinction, when it would have been more in accordance with the truth for it to be amended.

26. With a view to instruction, we are wont to call the ordinary method applied to Nature *the Anticipation of Nature* (because it is a rash and premature thing); but that method which is by due means elicited from things, *the Interpretation of Nature.*

27. Anticipations are strong enough to command consent; since if men were even to rave in one way and uniformly, they would be able to agree pretty satisfactorily amongst themselves.

28. Furthermore, *Anticipations* are far more powerful in winning assent, than *Interpretations;* since, being gathered out of a few instances, and these too for the most part those which occur familiarly, they forthwith dazzle the intellect, and fill the imagination; whereas, on the other hand, *Interpretations,* being gathered widely from things very various

and far separate, cannot suddenly strike the intellect; so that necessarily they must seem, as harsh and discordant opinions, almost like mysteries of the faith.

29. In the Sciences which are based on opinions and arbitrary views, the use of *Anticipations* and of Logic is good; since the object is to subdue the assent, not things.

30. Even if the talents of all ages were to come together, and unite and transmit to one another their labours, no great progress could be made in knowledge by *Anticipations*; because radical errors, and those ~~which arise in the first digestion of~~ the mind, are not cured by excellence of the functions and by subsequent remedies.

31. In vain is a great increase looked for in knowledge from the superinduction and ingrafting of new things upon the old; but a fresh beginning must be made from the lowest foundations, unless we would be for ever carried round in a circle, with meagre and almost contemptible progress.

32. The ancient authors retain their honours, and so too do all others; for we are not introducing a comparison of talents or powers, but of method; and ourselves sustain the character of a guide, not that of a judge.

33. No right judgment (one must speak openly) can be formed either with respect to our method, or to the discoveries resulting from it, by *Anticipations*, that is, by the system now in vogue; for we must

not be required to stand at the bar of that very thing which itself is arraigned by us.

34. Nor is it an easy matter to deliver or explain what we bring forward; because those things which are in themselves new will nevertheless be understood by comparison with the old.

35. It was a saying of Borgia concerning the expedition of the French into Italy,—that they had come with chalk in their hands to mark their lodgings, not with arms to force their way. So too our plan is that our teaching should quietly enter into souls fit and capable of it: for there is no object in confutation where we differ about first principles, and conceptions, and even about the forms of demonstration.

36. There remains, however, to us one and a simple manner of delivery—that we lead men to particulars themselves, to their series and orders; and that men, in their turn, should bid themselves for a while renounce conceptions, and begin to make acquaintance with things themselves.

37. The method of those who have held the "Acatalepsy" and our way agree somewhat in their beginnings; but in the end they are immensely separated and opposed. For they assert simply that nothing can be known; whereas we, that (not much in nature can be known by the way now in use: but they forthwith destroy the authority of both sense and intellect: we contrive and provide helps for the same.)

38. The Phantoms and false conceptions which have

hitherto preoccupied man's intellect, and are deeply rooted in it, not merely so besiege men's minds that truth can with difficulty approach; but also, where truth has had a passage allowed her, they will again occur and be troublesome in the Instauration of the Sciences, unless men be forewarned and defend themselves against them as far as is possible.

39. There are four kinds of Phantoms which lay siege to human minds. To them (for instruction's sake) we give names; and call the first kind *Phantoms of the Tribe;* the second, *Phantoms of the Cave;* the third, *Phantoms of the Market-Place;* and the fourth, *Phantoms of the Theatre.*

40. The raising of conceptions and axioms by means of true *Induction* is certainly the proper remedy for driving and clearing out Phantoms: yet there is great use in pointing out the Phantoms. For right teaching about Phantoms stands towards the Interpretation of Nature, as the teaching about confutation of Sophisms does to the common Logic.

41. The *Phantoms of the Tribe* are founded in Human Nature itself, and in the very tribe or race of man. For it is a false assertion, that "human sense is the measure of things"; whereas on the contrary, all perceptions both of sense and of mind are measured by the standard of man, not by the standard of the Universe; and the human Intellect is like an uneven mirror catching the rays of things, which mingles its own nature with the nature of things, and distorts and corrupts it.

42. The *Phantoms of the Cave* are the phantoms

of the individual. For each man has (besides the generic aberrations of human nature) some individual cave or den which breaks and corrupts the light of nature; either by reason of the peculiar and singular nature of each; or by reason of education and conversation of man with man; or by reason of the reading of books, and the authority of those whom each man studies and admires; or by reason of differences of impressions as they occur in a mind preoccupied and predisposed, or even and sedate; or the like. So that evidently the human spirit (according as it is placed in each individual) is a various thing, and altogether disturbed and, as it were, the creature of circumstance. Whence Heraclitus hath well said that "men seek knowledge in lesser worlds, not in the greater and common world."

43. There are also phantoms arising as it were from the intercourse and society of men with one another. These we call *Phantoms of the Market-Place*, on account of the commerce and consort of men. For men associate by means of discourse; but words are imposed at the will of the vulgar: and so a bad and foolish imposition of words besieges the intellect in strange ways. Neither do the definitions or explanations wherewith learned men have been accustomed to fortify and clear themselves in some cases, in any way set the matter to rights. But words clearly put a force on the intellect, disturb everything, and lead men on to empty and innumerable controversies and fictions.

44. Lastly there are phantoms which have en-

tered into the minds of men from the different dogmas of Philosophical systems, and even from perverted laws of Demonstration. These we name *Phantoms of the Theatre:* because we count that each Philosophy received or invented is like a Play brought out and acted, creating each its own fictitious and scenic world. Nor do we only speak of those philosophies and sects which are now flourishing, nor even of the ancient ones, since plenty more such Plays might be composed and got up; for the causes of errors utterly diverse may be nevertheless almost common. Nor again do we only understand this of the universal philosophies, but even of very many other principles and axioms of the sciences, which have gotten strength through tradition, credence, and neglect.

However, we must speak more at large and more distinctly about each of these kinds of Phantoms, so that we may caution the Human Intellect.

45. The Human Intellect, from its peculiar nature, easily supposes a greater uniformity and equality in things than it really finds; and though there are many things in nature unique, and full of inequality, yet it feigns parallels, correspondents, and relations which do not exist. Hence the figment "that in the heavens all things be moved through perfect circles," spiral lines and eccentrics being cast aside (except merely in name). Hence the Element of Fire with its Orb is introduced to make up the quaternion with those other three which are subjected to the senses—and farther, on the elements

(as they are called) is imposed at their pleasure, the tenfold progression of rarity, each after other; and fancies of the like kind. Neither does this vanity only prevail in dogmas, but even in simple conceptions.

46. The human Intellect, in those things which have once pleased it, (either because these have been received and believed, or because they delight,) draws also all other things to vote with and consent to these—and though the weight and multitude of contrary instances be the greater, yet either it does not observe them, or despises them, or draws distinctions, and so removes and rejects them—not without great and pernicious prejudice—in order that the authority of those previous conclusions may remain unshaken. And so he answered well, who, when the picture of those who had fulfilled their vows after escaping the peril of shipwreck were shown him hung up in a temple, and he was pressed with the question, did he not after this acknowledge the Providence of the Gods, asked in his turn, " But where are they painted who, after vowing, perished?" The same is the method of almost every superstition, as in astrology, in dreams, omens, judgments, and the like; in which men who take pleasure in such vanities as these attend to the event when it is a fulfilment; but where they fail, (though it be much the more frequent case,) there they neglect the instance, and pass it by. But in Philosophy and the Sciences this evil creeps in far more subtly—for there anything which has once approved itself to man corrupts ~~all other th~~ings.

(even though they be far surer and more powerful) and reduces them under itself. Farthermore, even though this satisfaction and vanity, of which we have spoken, were absent, yet such is the peculiar and perpetual wandering of the human Intellect, that it is more moved and roused by affirmatives than by negatives. Whereas properly it ought to be just to both, nay even, in the framing of any axiom, the force of the negative instance is the greater.

47. The human Intellect is most moved by those things which can strike and enter the mind simultaneously and suddenly; by these the fancy is wont to be filled and inflated. Then it feigns and supposes in some way, but almost imperceptibly, that every thing else is somehow similar to those few things by which the mind is occupied. But the Intellect is quite slow and unfit for that transition to remote and heterogeneous instances by which axioms are tried as it were by fire, unless the duty be enforced upon it by hard laws and stringent authority.

48. The human Intellect is restless, and cannot stop or be quiet, but presses forward—but in vain. And so one cannot suppose any extreme or limit of the Universe, but it always occurs, as a kind of necessity, that there must be something farther. Nor again can one think how eternity has flowed down to this very day: since that distinction, which is commonly received, between the Infinite "*a parte ante*" and "*a parte post*" can nohow stand; for it

must thence follow that one infinite is greater than another infinite, and so that the infinite can be consumed, and verge to the finite. There is a like difficulty as to the infinite divisibility of lines, arising from the impotence of thought. But this impotence of mind comes in with greater perniciousness in the discovery of causes: for though the most universal truths in nature ought to be positive, just as they are discovered, and have no real cause; yet the human Intellect, unable to rest, still seeks for something yet more noscible. Then, however, aiming at what is farther, it falls back on what is nearer, viz. final causes; which belong clearly to the nature of man, rather than to that of the universe; and from this fountain have they wondrously polluted Philosophy. But those are alike unskilful and frivolous Philosophers who seek for a cause in the highest universals, and who do not seek it in subordinate and lower truths.

49. The human Intellect is not of the nature of a dry light, but receives a tincture from the will and affections; which generates accordingly knowledge "ad quod vult," (according to its own wishes,) for what a man would rather was true, that he the more readily believes. And so it rejects what is difficult, being impatient of inquiry; what is sober, for it straitens hope; the deeper things of nature, for it is superstitious; the light of experience, for it is arrogant and proud, and fears lest the mind should seem to be employed on vile and floating subjects; paradoxes, because it dreads the opinion of

the vulgar; finally in innumerable ways, and those sometimes imperceptible, the affection tinges and infects the Intellect.

50. The human Intellect is far most hindered and led astray by the dulness, incompetency, and fallacies of the senses; so that those things which strike the sense outweigh those which do not do so immediately, even though these latter be the more important. And so thought almost ends with sight; so that there is little or no observation of things invisible. And so every operation of spirits shut up in tangible bodies lies hid, and escapes the notice of men. Every very subtle change, too, in the structure of the parts of grosser things (which men ordinarily call *alteration*, while in truth it is a conveyance, or movement through the least space) in like fashion lies unnoticed; and yet, unless these two, which we have spoken of, were explored and brought to light, nothing great, as far as regards results, can be done in Nature. Again, the nature of common air itself, and of all bodies which in their rarity surpass the air (and these are very many), is almost unknown. For the sense by itself is a feeble thing, and errant; neither do instruments avail much for the increasing the sense or its sharpening; but every true interpretation of Nature is achieved by means of instances, and fit and apposite experiments; wherein the sense judges only of the experiment, but the experiment of the nature and the thing itself.

51. The human Intellect is carried to abstracts

by reason of its ~~proper nature;~~ and feigns that those things, which are variable, are constant. Better is it to dissect Nature than to abstract her, as did the school of Democritus, which penetrated farther into Nature than the rest did. Matter ought rather to be considered, its structure and changes of structure, and simple action and law of action or motion; for Forms are fictions of the human soul, unless it be allowable to call the laws of action Forms.

52. Of this kind, then, are those Phantoms which we call *Phantoms of the Tribe*. They spring either from the uniformity of the substance of the human spirit, or from its prejudices, or from its limitation, or from its uneasy motion, or from the infusion of the affections, or from the incompetency of the senses, or from the manner of the impression.

53. *Phantoms of the Cave* draw their origin from the peculiar nature of each, whether mental or bodily; and even from education, custom, and circumstance. And in this class, which is varied and multiform, we will put forward those instances, in which caution is most needed, and which are the most powerful in polluting the purity of the Intellect.

54. Men love particular sciences and subjects of thought, either because they believe themselves to be the authors and discoverers of them, or because they have spent the greatest amount of labour upon them, and have been most accustomed to them. And men of this sort, if they betake themselves to Philosophy and universal subjects of thought, distort

and corrupt these by their previous fancies; and this is most especially conspicuous in Aristotle, who altogether enslaved his natural Philosophy to his Logic, and so rendered it nearly useless, and contentious. Again, the Chemists have, from a few experiments of the furnace, built up a fanciful Philosophy, which regards only a few cases; and farthermore Gilbert, after he had occupied himself most laboriously with researches on the Magnet, straightway constructed a Philosophy harmonious with that subject which had such immense weight with himself.

55. The following is the greatest and, as it were, radical distinction between minds, as to Philosophy and the Sciences. Some minds are stronger and fitter for noticing the differences of things; others for noticing their resemblances. For constant and acute minds can fix their contemplations, can linger, and fasten on every subtilty of differences; but sublime and discursive minds both recognise and compare even the most delicate and general likenesses of things. Each disposition falls readily into excess by grasping at either the gradations of things or their shadows.

56. Some spirits are given up to the admiration of Antiquity, others to the love and embrace of Novelty; but few are of such a temperament as to be able to keep the mean; but must either tear up what has rightly been laid down by the ancients, or despise what has been rightly contributed by the moderns. This takes place to the great detriment

of the Sciences and Philosophy, since these are likings not judgments as to Antiquity and Novelty: whereas Truth is to be sought not from the felicity of any particular time, which is variable, but from the light of nature and experience, which is eternal. And so these likings are to be abjured, and care must be taken lest the Intellect be hurried on by them to consent.

57. Contemplations of Nature and of bodies in their simplicity do break and lessen the Intellect; but contemplations of Nature and bodies in their composition and configuration do stupefy and relax it. This is best seen in the School of Leucippus and Democritus, when compared with the other Philosophies. For it is so engaged upon the particles of things as almost to neglect the fabrics; but the others look with so great astonishment upon the fabrics, that they do not penetrate through to the simplicity of Nature: and so these contemplations are to be alternated and interchanged, that so the intellect may be rendered at once penetrating and capacious, and those inconveniences we have mentioned, and the Phantoms arising from them may be avoided.

58. Let this then be our contemplative prudence in keeping off and removing *Phantoms of the Cave*, which chiefly arise from excess in composition and division, from likings to particular times, or from the largeness or smallness of objects. And as a general rule; every one who contemplates the nature of things must suspect whatever especially allures and captivates his own Intellect; and so much the more

caution must be used in judgments of this class, that the Intellect may be preserved in its justice and purity.

59. But the *Phantoms of the Market-place* are the most troublesome of all. These have stolen into the Intellect from the associations of words and names. For men believe that their reason rules over words; but it is also the case that words react and in their turn use their influence on the Intellect; and this has rendered Philosophy and the Sciences sophistical and inactive. But words for the most part are imposed at the will of the vulgar, and divide things by lines most conspicuous to the vulgar Intellect. When however a sharper Intellect or more diligent observation wishes to shift those lines, to make them more in accordance with Nature, then words cry out against it. Whence it comes that the great and solemn disputations of the learned often degenerate into controversies about words and names; with which (after the manner of foreseeing Mathematicians) it would have been more advisable to have begun, and to have reduced words to order by definitions. And yet these definitions (in things natural and subject to Laws of Matter) cannot cure this evil, since definitions themselves consist of words, and words beget words. And so it is necessary to recur to particular instances, and to their series and orders. This we shall mention presently, when we have arrived at the manner and plan of framing conceptions and axioms.

60. Phantoms, which are imposed on the Intellect

by means of words are of two kinds. Either they are the names of things which exist not, (for as there are things which have no names, through lack of observation, so too there are also names without things through fanciful supposition,) or they are names of things which exist, but are confused and ill-defined, and rashly and irregularly abstracted from things. Of the former kind are, Fortune, *Primum Mobile*, the orbits of planets, the element of fire, and such like fictions, which spring from vain and false theories. And this kind of Phantoms is the more easily ejected, because they can be exterminated by constant disowning and rejection of theories.

But the other kind is intricate and deeply rooted; it is produced by bad and unskilful abstraction. E. g. take some word, (*moist*, if you like,) and let us see how those things which are designated by this word agree. You will find that the said word *moist* is nought but a confused mark of diverse actions, which admit of no consistency or reduction to one head. For it signifies what readily surrounds another body; what is in itself indeterminable, and has no consistency; what readily yields in every direction; what readily separates and scatters itself; what readily gathers and collects itself; what readily flows and is set in motion; what readily adheres to another body, and renders it damp; what is readily reduced to a liquid state, or melts, when it was before consistent. And so, as soon as we are come to the predication and imposition of this name: if you take one sense, flame is moist; if another, air is not moist: if another, minute dust is moist; if another, glass is moist: so that it is clear that this notion is hastily abstracted from water only, and common and ordinary liquids, and that, too, without any due verification.

Furthermore, there are in words certain degrees of ~~wrongness and mistake.~~ ~~Less~~ faulty is the class of names of some substance, especially of *infimæ species*, and those well deduced (for the conceptions of *chalk*, or *clay* are good; of *earth*, bad); more faulty that of actions, as *generation*, *corruption*, *alteration;* most faulty that of qualities (with the exception of immediate objects of sense) as *heavy*, *light*, *rare*, *dense*, &c.; and yet in all these it must be that some conceptions are a little better than others, according as things in greater or less plenty strike the human senses.

61. But the *Phantoms of the Theatre* are not inborn, nor have they crept secretly into the Intellect. They are openly put in and received from the fables of theory and perverse laws of demonstration. To attempt and undertake the confutation of these would nohow agree with what has already been said by us. For where we neither agree on first principles, nor as to the methods of demonstration, there all arguing is at an end. And this is well, for so the Ancients retain the honour due to them. For nothing is taken from them while the question is altogether of the way. The lame man (as they say) in the right way outstrips the swift

runner who declines from it; and it is also quite clear, that the more able and swift he is who runs not in the right way, the further he must wander.

Our method, however, of discovering the Sciences is one which leaves not much to acumen and strength of wit, but nearly levels all wits and intellects. For just as, with a view to the production of a straight line or a perfect circle, much depends on steadiness and practice of hand, if it be described by hand alone, whereas if a ruler be made use of or a pair of compasses, little or nothing depends on them; so exactly in the case of our method.

And yet, though there be no use in particular confutations, yet something must be said respecting the sects and classes of theories of this sort; then afterwards concerning the external signs also of their weakness; and lastly, as to the causes of such ill-hap, of so long and general a consent in error: that so the approach to the truth may be less difficult, the human Intellect more willingly cleansed, and Phantoms banished.

62. *Phantoms of the Theatre*, or of Theories, are many, and can be many more, and perhaps one day will be. For unless, these many ages, men's wits had been occupied on Religion and Theology; and had not civil polities also (especially Monarchies) been so averse to such novelties even in matters of contemplation, that men if they take to Philosophy must do it at the risk and detriment of their own fortunes, as being not only without reward, but even exposed to contempt and ill-will; there would

have been introduced without a doubt, a multitude of sects of Philosophies and Theories, like to those which of old times flourished in great variety among the Greeks. For just as plenty of schemes of the heavens can be built up upon the phenomena of the sky, so likewise, and much more, can various dogmas be founded and built up upon the phenomena of Philosophy. And the Plays of this kind of Theatre are also like those current in the Theatre of the Poets, in that the plots prepared for the stage are neater and more elegant and pleasing, than the true plots of history.

Generally, however, for the groundwork of Philosophy either much is drawn from few things, or little from many; so that on either hand Philosophy is based upon too narrow a foundation of experience and Natural History, and dogmatises from fewer instances than is right. For the "rational" class of Philosophizers catch up various common things from experience, and these neither ascertained for certain nor diligently examined and weighed; the rest they make depend on meditation and activity of wit.

There is too another class of Philosophizers, who have laboured sedulously and accurately at a few experiments, and have dared to educe and build up thence their Philosophies, twisting everything else wonderfully into agreement with them.

There is also a third class, to wit, of those who from belief and reverence, mix up Theology and traditions; among whom the emptiness of some has turned aside to seek and derive knowledge from spirits and genii. Thus this root of error, this false Philosophy, is in kind threefold, *sophistical*, *empirical*, and *superstitious*.

63. An example of the ~~first kind is most plainly~~ seen in Aristotle, who corrupted Natural Philosophy with his Logic; for he made the Universe out of his Categories; assigned to the human soul, the noblest of substances, a genus from words of second Intention; settled the business of *density* and *rarity*, whereby bodies occupy greater and less dimensions or spaces, by the cold distinction between Act and Power; asserted that each body had its peculiar and proper motion, and, if it participated in any other motion, it was moved from some other quarter; and imposed innumerable other fictions on the nature of things at his own will; being everywhere more anxious as to how one should extricate oneself by an answer, and how some positive reply in words should be made, than as to the internal Truth of things. And this is best shown if his Philosophy be compared with the other Philosophies which were well known and received among the Greeks. For the *homoiomera* (similar constituent parts) of Anaxagoras, the "Atoms" of Leucippus and Democritus, the "Heaven and earth" of Parmenides, the "strife and friendship" of Empedocles, the "resolution of bodies into the indifferent (ἀδιαφόραν φύσιν) nature of Fire," and "the return of the same to density" of Heraclitus, have all something of the Natural Philosopher in them; and have a savour of the nature of things, of experience, and of bodies: whereas Ari-

stotle's Physics for the most part are nothing but a sound of Dialectical Terms; and these he has also treated of again in his Metaphysics under a more imposing title, and as forsooth, more *real* and not *nominal.* Nor let it stagger any one that in his Books on Animals, and in the Problemata, and in other of his tractates, there is a frequent handling of experiments. For he had first passed his judgment: nor did he even make a proper use of experience to fortify his judgments and Axioms; but after he had passed judgment at his will, he then brought round poor Experience, tortured and a captive, to his conceits. So that even on this head he is more to be accused than his modern followers (the class of Scholastic Philosophers) who have utterly abandoned experience.

64. But the *Empiric* kind of philosophy produces views more misshapen and monstrous than the *Sophistic,* or "rational" school. For its foundations are laid not in the light of vulgar conceptions (which though it be slight and superficial, yet is it in a manner universal, and pertinent to many things) but on the narrow and dark basis of a few experiments. And so such a Philosophy seems probable and almost certain to those who are daily occupied with experiments of this kind, and have corrupted their imagination by means of them: to all others it seems incredible and vain. A notable example hereof is to be met with in the Chemists and their dogmas; however, this is scarcely to be found any where at present, except perhaps in the philosophy

of Gilbert. Still a caution was by no means to be omitted with respect to Philosophies of this class; because we already foresee in mind, and augur, that if ever men, roused by our monitions, should bid farewell to sophistical teaching, and betake themselves earnestly to experience; then certainly a great peril will be imminent from Philosophies of this class, on account of the premature and rash haste of the Intellect—its leaping and flight to generals and to the first principles of things. This evil we ought even now to meet.

65. But the corruption of Philosophy from *Superstition* and admixture of Theology, spreads altogether more widely, and introduces the greatest amount of evil both into whole systems of Philosophy and into their parts. For the human Intellect is no less exposed to impressions of the Fancy than to impressions of vulgar conceptions. For the pugnacious and sophistical kind of Philosophy ensnares the Intellect; but this other, which is fanciful, tumid, and quasi-poetical, flatters it. For there dwells in man a certain ambitionof Intellect no less than of Will; especially in profound and elevated characters.

An example of this kind is plainly to be seen among the Greeks, especially in Pythagoras, but in his case it is joined with a somewhat coarse and heavy superstition; it is more dangerous and subtle in Plato and his school. For this class of evil is found in parts of the other Philosophies, in the introduction of *Abstract Forms*, *Final Causes*, and *First Causes;* and in the omission most frequently of middle causes;

and such like. But here we must use the greatest caution. For the Deification of Error is the worst of all things, and it is to be regarded as the plague of the Intellect, if vanity be worshipped. Some of the moderns have indulged this vanity with the greatest carelessness: and have endeavoured to found a natural Philosophy on the first chapter of Genesis, on the Book of Job, and other Sacred Scriptures, so "seeking the dead among the living." And by so much the more is this vanity to be restrained and coerced, because there springs from an unwholesome mixture of things human and divine, not merely fantastical Philosophy, but heretical Religion. And so it is very salutary, if with due sobriety of mind those things only be rendered to Faith, which are Faith's.

66. We have now spoken of the unsound authorities of Philosophies which have their foundations either in *vulgar conceptions*, or in a *few experiments*, or in *superstition*. Next we must speak also of the faulty materials of contemplation, especially in natural Philosophy. Now the human Intellect is affected by the view of those things which take place in the mechanical arts, wherein bodies are as much altered as possible by means of composition and separation: and thinks that something similar takes place in the universal Nature of things. Hence flowed that fiction of elements and their concourse, for the composition of natural bodies. Again, when man contemplates the liberty of Nature, he falls in with the species of things, of animals, plants, minerals; thence

he easily slips into the belief that there are in Nature certain primary Forms of things, which Nature strives to educe; and that all variety proceeds either from impediments and aberrations of Nature in the accomplishing of her work, or from the conflict of diverse species, and the transplanting of one into another. The former way of thinking has brought forth for us prime and elementary qualities, the second occult properties and virtues specifical: while each of them belongs to the empty fictions of contemplation, wherein the mind rests quietly and is turned aside from more solid subjects. But Physicians spend their time better on the secondary qualities and operations of things, on Attraction, Repulsion, Attenuation, Inspissation, Dilatation, Astriction, Discussion, Maturation, and the like; and had not those two figments above noticed (of elementary qualities, and specific virtues) corrupted these latter, which are rightly observed, by reducing them to prime qualities, and subtle and incommensurable mixtures thereof; or by not carrying them on with still greater diligence of observation, to qualities of the third or fourth order, but by unseasonably breaking off contemplation; assuredly they would have prospered far better than they have. Nor are virtues of this kind (I do not mean the same identically, but similar ones) to be sought for only in the medicines for the human body; but also in the changes of all other natural bodies.

But it causes still more evil that contemplation and inquiry take the quiescent principles of things *ex quibus*, not the motive principles *per quæ* things come into being. For the former of these refer to mere discourse, the latter to action. Nor are those ordinary differences of Motion, which are noted as received in natural Philosophy, of any value, i. e. *generation*, *corruption*, ~~*augmentation*,~~ *diminution*, *alteration*, and *translation*. Forsooth what these mean is this—that if a body, otherwise not moved, be moved in place only, this is "*translation*": if place and species remaining, it be changed in quality, this is "*alteration*": if however through that change the mass itself and quantity of the body do not remain the same, this is the motion of "*augmentation*" and "*diminution*": if things be so far changed as to change their species even and substance, and migrate into other (species and substances) this is *generation*" and "*corruption*". But these are merely popular distinctions, and in no way penetrate into Nature: and are measures and periods only, not species of Motion. For they suggest only *how far*, not *in what manner* or *from what source*. For they point out nothing respecting the appetition of bodies or the procession of their parts; but only, when that Motion coarsely exhibits to the senses the thing otherwise than before, do they then begin their division. And even when they wish to point out something respecting the causes of Motion, and to institute a division of them, they there introduce a difference between Motion natural and violent, in the most slovenly manner: a distinction which springs entirely from vulgar conceptions:

for every violent Motion is also in reality natural, viz: it arises when an external efficient puts Nature in operation otherwise than before.

But to put these aside—if any one, for example, were to observe that bodies have a mutual appetition of contact, so as not to allow the unity of Nature to be entirely broken or dissevered, so that a vacuum be caused: or if any one should say that bodies have in them an appetition towards returning into their own natural dimensions or extent, so that after being stretched beyond or compressed within it, they immediately endeavour to recover themselves and return into their former sphere and extent: or if any one should say, that there is in bodies an appetition towards gathering together with masses of substance homogeneous—i. e. in dense bodies towards the earth, and in more subtle and rarified bodies towards the circuit of the heavens: these and their likes are the true physical kinds of Motions. The others are clearly logical and scholastic, as is manifest from this review of them.

Nor, again, is it a less evil, that in their Philosophies and Contemplations, labour should be spent on the investigation and treatment of the first principles of things and the ultimate Limits of Nature: for all utility and power of operation lies in the middle principles. Hence it arises that men will not cease abstracting Nature till they have reached potential and unformed Matter; and on the other hand will not cease dividing Nature till they have arrived at the Atom—which things, granted they were true, can be of but little avail in forwarding the fortunes of man.

67. One must also caution the Intellect against the intemperance of Philosophies in the matter of granting or withholding assent; because intemperance of this kind seems to fix and in a way so to perpetuate Phantoms, as to take away all approach for the purpose of removing them.

The excess is of two kinds; the one that of those who dogmatise readily, and render the Sciences positive and dictatorial; the other, that of those who have introduced *Acatalepsy* ("Incomprehensibility") and vague inquiry without limit. The former of these depresses the Intellect, the latter enfeebles it. For the Philosophy of Aristotle after that (like the Turks with their brethren) it had murdered all other Philosophies with its contentious confutations, then dogmatised on every subject; and he himself again suborns questions to come forward at his will, which he thereupon despatches, so that all things should be certain and decreed—a course of action which prevails yet among his successors, and is in vogue.

But Plato's school introduced *Acatalepsy:* first as in jest and irony, through hatred of the ancient Sophists, Protagoras, Hippias, and the rest, who feared nothing so much as appearing to doubt upon any subject. But the new Academy made a dogmatism of its *Acatalepsy*, and held it as their tenet. And although this is more honest than the license of dogmatising, since they say for themselves that they do not at all confound inquiry, like Pyrrho and the Sceptics, but have something which they can follow as Probability, though not what they can hold as Truth; nevertheless after the human mind has once despaired of the discovery of truth, all things in all ways become more languid, and therefore men prefer to turn aside to pleasant disputations and discourses, and sundry wanderings through the fields of knowledge, rather than sustain any severity of inquiry. But as we observed at the beginning, and continually hold in view; from human Sense and Intellect, and their weakness, their just authority is not to be taken, but assistance is to be provided for them.

68. And now we have spoken of each kind of *Phantom* and its equipage; all of which must be refused and renounced with constant and solemn abjuration, and the Intellect must be entirely freed and cleansed from them; so that there must be scarcely any other approach to the kingdom of man, which is founded in knowledge, than to the kingdom of Heaven, into which there is no entrance save for a childlike character.

69. But vicious demonstrations are as it were the bulwarks and fortresses of Phantoms; and those which we have in Logic fall little short of entirely handing over and enslaving the universe to human thought, and thought to words. For demonstrations, in their potentiality, are themselves Philosophies and Sciences. For as they are, and accordingly as they are well or ill-founded, such in consequence are Philosophies and contemplations.

Farther; those are deceptive and incompetent, which we make use of in that universal process which leads from sense and things to Axioms and Conclusions. Now this process is fourfold, and fourfold are its faults. 1. The impressions of the sense itself are faulty; for the sense both falls short and misleads. Now to failures substitutions must be supplied; to fallacies rectification. 2. Conceptions are badly abstracted from the impressions of the senses; and are ill-defined and confused, when they should have been limited and well defined. 3. That kind of Induction is bad, which concludes the principles of the Sciences by means of simple Enumeration, without application of exclusions and solutions, or proper separations of Nature. 4. That method of discovery and proof, which first establishes the most general principles, and then applies to them and proves by them the intermediate Axioms, is the mother of errors, and calamity of all sciences. But we will speak more largely of those points which we now incidently touch upon, when we put forward the true way of interpreting Nature, after we have completed these expiations and purifications of the mind.

// 70. Experience is far the best Demonstration: provided it adheres to the experiment itself. For if it pass on to other instances which are thought similar, it is fallacious, unless that passage be made duly and in order. But the method of experiment which men now make use of is blind and stupid: and so, while they wander and stray without any certain way, but only take counsel from the occurrence of circumstances, they are carried about to many points, but advance little; and are sometimes glad, sometimes distracted; and ever are finding something farther to seek after. For so it mostly happens that men make their experiments lightly and as it were in play, by varying little by little experiments already known; and if the thing does not succeed, they grow disgusted, and leave off their attempt. Even if they gird themselves more seriously, constantly, and laboriously for experiments; yet they spend their toil in turning over some one; as Gilbert did with the magnet, the Chemists with Gold. This however men do with as unskilful as futile a purpose. For no one happily explores the nature of a thing in the thing itself; but ~~the inquiry should be extended to what is~~ more general. But if men even build up some science and dogmas from experiments, yet they almost always turn aside with a hasty and untimely eagerness to practical application; not only for the sake of the use and fruit of that same application to practice, but also that in some new work they may snatch for themselves as it were a pledge that they will not employ themselves uselessly in the rest; and they even make the most of themselves to others, in order that they may gain a higher reputation in those subjects on which they are engaged. Whence it comes that, like Atalanta, they go aside to take up the golden apple, so meanwhile interrupting their course and letting victory slip out of their hands; But in the true course of experiment, and the carrying it on to new effects, the Divine Wisdom and Order are entirely to be taken as our examples. Now God on the first day of Creation, created only Light; and gave a whole day for that work, and on that day created no material object. Similarly, in experience of every kind, first the discovery of causes and true Axioms is to be made; and light-bringing not fruit-bringing experiments to be sought for. And Axioms rightly discovered and established supply practical uses not scantily but in ✓ crowds; and draw after themselves bands and troops of effects. But we will speak hereafter of the ways of experiment which are as much besieged and blockaded as are the ways of judgment; at present we speak only concerning ordinary experience, as a faulty kind of demonstration. Now however the order of things demands that we subjoin some observations on those indications of the unsoundness of Philosophies and Contemplations now in use, of which we a while ago made mention, and on the causes of a thing at first sight so wonderful and incredible. For the knowledge of indications prepares assent: while the unfolding of causes removes marvel: and these two are very useful towards a more easy and mild extirpation of Phantoms from the Intellect.

71. The sciences we possess have almost all descended from the Greeks. For what Roman, Arabian, or the more modern authors have added is not much or of much moment; and such as it is, it is

founded on the basis of the discoveries of the Greeks. Now the wisdom of the Greeks was showy and disputatious; a kind most adverse to inquiry into truth. And so that title of *Sophist*, which was contemptuously applied to and cast upon the ancient Rhetoricians, Gorgias, Protagoras, Hippias, and Polus, by those who wished to be regarded as Philosophers, is also applicable to the whole race, to Plato, Aristotle, Zeno, Epicurus, Theophrastus, and their successors Chrysippus, Carneades, and the rest. This was the only difference; that the former class was erratic and mercenary, visiting different states, shewing off their wisdom, and exacting pay; while the other was more dignified and generous, that is, the class of those who had fixed residences, and opened schools, and philosophised gratis. But yet both classes (though they differed otherwise) were for show, and used to reduce matters to disputations, and instituted and fought for sundry sects and systems of Philosophy; so that their teaching was almost what Dionysius said not badly against Plato — " the words of idle old men to inexperienced youth". But those more ancient Greeks, Empedocles, Anaxagoras, Leucippus, Democritus, Parmenides, Heraclitus, Xenophanes, Philolaus, and the rest (we omit Pythagoras as superstitious) did not open schools (so far as we know): but with a greater silence, severity, and simplicity, that is, with less affectation and show, betook themselves to the inquiry after Truth. And so they succeeded better, save that their works are eclipsed by those lighter works, which better answer to and please the whim and inclination of the vulgar; time (like a river) bearing down to us what is lighter and more inflated, but sinking what is weightier and more solid. Nor yet were even these entirely free from the fault of their nation; but leaned too much to the ambition and vanity of building a sect, and of catching the breath of popular applause. But the inquiry after Truth must be regarded as hopeless, when it turns aside after worthless objects of this kind. Nor is that sentence, or rather prophecy of an Egyptian priest concerning the Greeks to be omitted, who said, "they were ever children; and had neither antiquity of knowledge, nor knowledge of antiquity." And surely in this they are like children—they are ready to chatter, but cannot beget; for their wisdom seems to be wordy, and barren of results. And so the indications taken from the origin and family of the Philosophy in vogue are not good.

72. Nor are those indications which may be gathered from the nature of the Time and Age, much better than those which are taken from the nature of the Place and Nation. For throughout that Age the acquaintance of men with either Time or the globe was narrow and slender; which is far the greatest evil, especially to those who depend entirely on experience. For they had not the history of a thousand years, which was deserving of the name of History, but only tales and rumours of Antiquity. They knew but a small part of the regions and districts of the earth; while they called all northern nations

indiscriminately, Scythians, all western, Celts: and knew nothing of Africa beyond the nearest parts of Æthiopia, nothing of Asia beyond Ganges; much less did they know of the provinces of the New World, even by hearsay, or any certain and constant report; and farther, many climates and zones, in which innumerable peoples breathe and live, they declared were uninhabitable; and, besides, even the travels of Democritus, Plato, and Pythagoras, not distant indeed, but rather mere suburban excursions, were talked of as something great. But in our days both many parts of the New World, and the farthest limits of the Old are well known on all sides, and the heap of experiments has infinitely increased. Wherefore if, according to the fashion of Astrologers, indications are to be taken from the time of nativity and birth; nothing great seems to be indicated respecting these Philosophies.

73. Among indications, none is surer or more noble than that taken from the fruits produced. For the fruit and result discovered stand as sponsors and sureties for the truth of Philosophies. Now from those Philosophies of the Greeks, and their subdivisions through particular branches of knowledge for now so many years, scarce one experiment can be adduced which bears on the alleviation and assistance of the state of men, and can be reported as really obtained from the speculations and dogmas of Philosophy. And Celsus ingenuously and prudently confesses that the experiments of medicine were first discovered, and that men afterwards

philosophised upon them, and tracked out, and assigned their causes; but that they did not follow the contrary order, viz. invent and bring forth experiments from Philosophy and the discovery of causes. And so it was not wonderful that among the Egyptians (who deified and consecrated the discoverers of things) there should have been more images of brute beasts than of men: for brute beasts, through their natural instincts, have given birth to many discoveries, where men, through discourse and rational conclusions, have exhibited few or none. Certainly, the industry of the Chemists has brought forth some; but this has been incidentally and by the way, or by some variation of experiments, (as the Mechanicians are wont to do,) not by any Art or Theory; for that which they have framed more disturbs than aids experiments. The discoveries of those too who have been engaged on Natural Magic (as it is called) are found to be few, trifling, and not far from imposture. Wherefore, even as it is a caution in Religion, that Faith be shown by Works, so the same is very well transferred to Philosophy. It should be judged by its fruits, and be counted vain if it be barren: and still more so, if instead of the fruit of the vine and the olive, it bear only the thistles and thorns of disputations and contention.

74. Indications are also to be gathered from the growth and progress of Philosophies and Sciences. For those things which are founded upon Nature increase and grow: but those which rest upon opinion

are varied only, not increased. And so, if those doctrines had not been utterly torn up like plants from their roots; but had been fixed in the womb of Nature, and nourished by the same, that could by no means have occurred, which we see has been taking place for twice a thousand years: viz. the Sciences would not have been treading in their own footsteps, and remaining in almost the same state, and have gotten no memorable increase; but rather they have flourished most under their first author, and then afterwards have declined. But in Mechanical Arts, which are founded upon Nature and the light of experience, we see the contrary follow: for these (as long as they are popular) as being full of some life, continually flourish and increase; at first rude, then convenient, afterwards polished; always increasing.

75. Again, another Indication is to be taken; (if indeed the name of *Indication* fits this case, where rather it should be *testimony*, and of all testimonies the strongest;) from the confession of those authors themselves whom men now follow. For even they who with so great daring dogmatise on things, from time to time, when they return to themselves, betake themselves to complaints as to the subtilty of Nature, the obscurity of things, the infirmity of human wit. If this were done with simplicity, it might perhaps deter the more timid from farther inquiry, but spur on and incite those of a quicker and more confident wit to further progress. But it is not enough for these men to make confession of themselves, but whatever is unknown to or un-

touched by themselves or their masters, this they place without the limits of possibility; and declare, as from authority of their art, that it is impossible to be known or done; thus with utmost pride and envy converting the feebleness of their own discoveries into a calumny upon Nature herself, and to the despair of every one else. Hence sprang the school of the New Academy which held "Acatalepsy" as a dogma, and condemned mankind to everlasting darkness. Hence the opinion that Forms or the true differences of things (which in reality are laws of pure action) are impossible to be discovered, and beyond man. Hence those opinions on the active and operative side: such as that the heat of the sun and of fire differ essentially: lest, forsooth, men should think themselves able to produce and form by means of fire anything similar to those things which Nature makes. Hence the notion that composition alone is the work of man, but commixture the work of Nature only; lest forsooth men should hope for any generation or transformation of natural bodies by means of art. And so from this Indication men readily persuade themselves not to involve their fortunes and labours with dogmas which are not merely desperate, but even devoted to desperation.

76. Nor is the following Indication to be passed by,—that there was of old so great a dissension among Philosophers and variety of schools: a thing which sufficiently shews that the way from the Senses to the Intellect was not well made, when

the same material of Philosophy, (the nature, that is, of things) is carried off and drawn aside into so wide and multiplied errors. And although in these days dissensions and differences of dogmas on first principles, and on whole systems of Philosophy are for the most part extinct; yet around parts of it there still remain innumerable questions and controversies; so that it is quite clear that neither in systems of Philosophy nor in methods of demonstration is there anything certain or sound.

77. Then as to the opinion of men, that there is a great consent in Aristotle's Philosophy; since after its promulgation the systems of the Ancients ceased and became obsolete, while in after-times nothing better was invented, so that it seems to have been so well laid down and founded as to draw to itself both time before and after it: First, what men think about the cessation of ancient systems of Philosophy after the production of Aristotle's works, is false; for for long after, even down to Cicero's days, and the following ages, the works of the old Philosophers remained. But in times following, through the inundations of Barbarians upon the Roman Empire, after that human learning had as it were suffered shipwreck; then indeed the Philosophy of Aristotle and Plato, like planks of a lighter and less solid material, were preserved among the waves of Time. But this plea of consent is deception, if men would look a little more sharply into it. For a true consent is that which consists in unanimity of free judgments (after due investigation). But by far

the greatest number of those who have given in their assent to Aristotle's Philosophy have enslaved themselves to him from prejudice and authority of others; so that it is rather obsequiousness and concurrence than consent. But even if this had been a true and wide-spread consent, so little ought it to be held as true and sound authority, that it even ought to produce a violent presumption to the contrary. For that is of all auguries the worst which is drawn from consent on intellectual subjects: save in matters of Divinity and Politics, in which suffrages have weight in decision. For nothing pleases the multitude, unless it either strikes the imagination, or binds the Intellect with ties of vulgar conceptions, as has been said above. And so the saying of Phocion—"that men ought straightway to examine themselves as to what error or fault they have committed, when the multitude assents to and applauds them"—may very well be transferred from things moral to things intellectual. This Indication therefore is among the most unfavourable. And so it has now been declared that the Indications of truth and sanity of the systems of Philosophy and the Sciences in use are in evil case: whether they be taken from their origins, or from their fruits, or their progress, or from the confessions of their authors, or from consent.

78. Now however we must come to the Causes of Errors, and of so determined a continuance in them through so many ages. These Causes are very many

and very powerful, and all wonder is at an end that what we bring forward should up to this time have escaped men's notice and have been concealed; and wonder only remains that these matters could even now have entered into any man's mind, or become subject for his thoughts: and this indeed (as we think) is more the result of some felicity than of any excellent faculty: so that it ought to be regarded as the birth of Time rather than as the birth of Wit.

First, the number of Ages, if one considers the matter rightly, is reduced to very narrow limits. For out of five and twenty centuries, in which the memory and learning of men has been made use of for the most part, scarce six can be set apart and picked out, as having been fruitful in sciences or favourable to their advancement. For there are deserts and wastes in time no less than in regions. For only three revolutions and periods of learning can be rightly counted up: one among the Greeks; a second among the Romans; the last among ourselves, that is, the western nations of Europe: to each of which scarcely can two centuries be rightly assigned. The intermediate periods of the world were unfortunate, as far as concerns a fruitful or rich crop of knowledge. For there is no reason for mentioning either the Arabians or the Schoolmen, who in those intermediate times rather wore away knowledge by their numerous treatises than increased its weight. And so the first Cause of so mean a progress in knowledge is rightly and duly referred to the small part of time which has been propitious to them.

79. In the second place a Cause of very great moment in every way presents itself, viz. that in those very Ages in which men's wits and letters flourished most or even moderately, Natural Philosophy got for its share the smallest part of human labour; and yet she ought to be regarded as the great Mother of Sciences. For all Arts and Sciences, if torn from this root, are polished, it may be, and prepared for use; but do not grow much. Now it is manifest that after the Christian Faith was received and had grown strong, far the largest number of the most excellent Intellects betook themselves to Theology; and to it the largest rewards were offered and help of all kinds was most plentifully afforded: and this study of Theology for the most part occupied that third part or period of time among us the western Europeans; and the more so because pretty nearly at the same time letters began to flourish, and Theological controversies to bud. But in the preceding age, during that Second Period (that of the Romans) the chief meditations and industry of Philosophers were occupied and consumed on Moral Philosophy, (which stood to the Heathen in the stead of Theology); and besides, the noblest wits of those times for the most part applied themselves to civil affairs, on account of the magnitude of the Roman Empire, which needed the labour of a vast number of persons. But that Age in which Natural

Philosophy seemed most to flourish among the Greeks was a shortlived particle of time: since those seven who were called the Wise Men, (in the older times,) all, with the exception of Thales, applied themselves to Moral Philosophy, and civil duties; and (in the later times) after that Socrates had brought down Philosophy from Heaven to Earth, Moral Philosophy prevailed still more, and turned the wits of men away from Natural.

But even that very period of time, during which inquiries concerning Nature have flourished, has been corrupted and rendered useless by contradictions and the ambition of new opinions. And so, seeing that through these three periods Natural Philosophy has suffered so great neglect or hinderance, no wonder if men have made but little progress in it, when they were altogether occupied on other matters.

80. In addition to all this, Natural Philosophy has scarcely obtained, especially in these later times, a man of leisure and disengaged among those who have laboured on it, unless perhaps any one were to bring forward the example of some monk working in his cell, or nobleman in his villa. But Natural Philosophy is made a kind of passage and bridge to other subjects.

And thus this mighty Mother of Sciences has with wonderful indignity been degraded to the duties of a servant: to wait upon the requirements of Medicine or Mathematics, and to wash and imbue as it were with a fresh tincture the immature wits of young men, in order that they may afterwards receive another tincture more happily and readily. Meanwhile let no one look for a great progress in the Sciences (especially in the operative part of them) unless Natural Philosophy be drawn out to particular Sciences, and the particular Sciences again be led back to Natural Philosophy. For it arises hence that Astronomy, Optics, Music, most of the Mechanical Arts, Medicine herself, and (which one would more wonder at) Philosophy moral and civil, and Logical Sciences, have hardly any depth, but only glide over the surface and variety of things: because, after those particular Sciences have been divided off and established, they are no longer nourished by Natural Philosophy, which could have imparted to them new strength and increase from the sources and true contemplations of motions, rays, sounds, texture and formation of Bodies, affections, and Intellectual apprehension. And so no wonder that the Sciences do not grow, since they are separated from their roots.

81. Again; another potent and mighty Cause of the small progress of knowledge is the following; It is impossible to advance properly in the course, when the goal itself is not rightly placed and fixed. Now the true and legitimate goal of the Sciences is none but this: that human life be enriched with new discoveries and wealth. But the great body of teachers relishes nothing of this, but is clearly hireling and professional; unless

perhaps it sometimes happens that some artisan of a quicker wit, and eager for glory, gives his attention to some new invention: and for the most part even this is done with waste of substance. But with the greatest number, not only do men not set it before themselves to augment the mass of sciences and arts, but they even only take from or seek out of the mass which is ready at hand just what they may be able to turn to professional uses, or gain, or reputation, or advantages of this kind.

Then, even if any one in so great a multitude seeks after Science from a true liking for it, and for its own sake; yet even he will be found to follow after a variety in objects of contemplation and in doctrines rather than a severe and rigid inquiry after truth. Again; if any one else be by chance a more severe inquirer into truth; yet even he will propose to himself such a condition of truth as may satisfy the mind and intellect by giving the causes of things which have been now long known; not one which may attain to new pledges of effects, and new light of axioms. And so, if the end of knowledge has not yet been well laid down by any one, no wonder if error follow in those things which are subordinate to the end.

82. Now, just as the end and goal of Science have been ill laid down among men; so again, even if they had been rightly laid down, men would have still chosen for themselves an entirely erroneous and impassable way. It must have struck the mind of any one who has thought well about the subject with

astonishment to see that it has never been matter of care or desire with any man to open and pave a way for the human Intellect from the senses themselves and from well-ordered and composed experience: but that all things have been given up either to the darkness of traditions, or to the whirl and eddy of arguments, or to the waves and mazes of chance and wandering and ill-combined experience. But let any one consider with sobriety and diligence what that way is which men have been accustomed to follow in inquiry and discovery of any thing. And first, without doubt, he will notice that simple and inartificial method of discovery which is most familiar to men. This is none other than this—that he who prepares and girds himself for the discovery of any thing, first inquires into and unfolds what has been said on the subject by others; then he adds his own thoughts, and by means of much movement of mind, stirs up his own spirit, and, as it were, invokes it to open out to him its oracles: a process which is entirely without foundation, and turns solely on opinions.

Another may call to his aid for discovery Logic, which only in name belongs to the subject in ~~hand.~~ For the discoveries of Logic are not those of Principles and chief Axioms, of which the Arts are composed, but only of those things which seem agreeable to them. For Logic with its well-known answer refers the more curious and importunate and those who give themselves trouble, and who interrogate her concerning proofs and discovery of Principles or Prime Axioms, to faith, and to the swearing of allegiance to each art in particular.

There remains bare experience; which, if it offers itself, is called Chance; if it is sought for, Experiment. But this kind of experience is nothing but (as they call it) "a loose broom" and mere groping, such as men make use of in the night, trying every thing if by chance they may hit upon the right way; whereas it would be much more satisfactory and well-considered to wait for day, or to light a torch and then commence the journey. But the true order of experience first lights a torch, then points out the way by means of the light, by beginning with well-ordered and digested experience, which is nohow misplaced or vague; and by drawing out thence axioms, and from the axioms when established new experiments; for not even did the Divine Word operate on the mass of things without order.

And so let men cease to wonder, if the course of the sciences be not perfected, when men have entirely wandered from the way: either by utterly leaving and deserting experience, or by involving themselves, and wandering about in it as in a labyrinth; whereas rightly appointed arrangement leads with constant path through the woodlands of experience to the open country of Axioms.

83. Now that disease has grown wonderfully in consequence of a certain opinion, or ingrained inflated and hurtful notion, that the majesty of the

human Mind is lessened if it be employed long and much on experiments and particulars subject to the sense, and definite in their matter: especially as things of this kind are wont to be laborious for inquiry, ignoble for meditation, for discourse harsh, for practice illiberal, infinite in number, and of a delicate subtilty. And so at last the matter has now come to this, that the true way is not only deserted, but even shut up and barred; experiment being disdained, not merely abandoned or badly carried on.

84. Again; a reverence for Antiquity, and the authority of men who have been held great in Philosophy, and subsequent Consent, have stopped men from progress in the Sciences, and have almost enchanted them. Now of Consent we have spoken above.

But the opinion about Antiquity which men cherish is altogether slovenly, and scarcely agrees with that name. For the old age and fulness of years of the world are rightly to be counted for Antiquity; and this ought to be ascribed to our times, not to the younger age of the world as it was with the Ancients. For that age, with respect to us, is ancient and elder; with respect to the world itself, modern and younger. And truly, as we expect a greater knowledge of human affairs, and a maturer judgment from an old man than from a youth, by reason of his experience, and the variety and plenty of the things he has seen and heard, and on which he ~~has thought~~; so in like manner from our age ~~also (did it~~ but know its own strength, and were it willing to essay and exert it) it is fitting that far greater things should be expected than from former times, since the age of the world is greater, and it has been enriched and ~~stocked with~~ an ~~infinite~~ multitude of experi~~ments and observati~~ons.

Nor is it to be counted for nothing that through lengthy voyages and travels (which have become so frequent in our day) very many things in Nature have appeared and been discovered, which might throw a new light upon Philosophy. And surely it would be disgraceful to mankind, if the regions of the Material Globe, i. e. of land and sea, and of the stars, should be immensely laid open and illustrated, while the limits of the Intellectual Globe were bounded by the discoveries and narrowness of the Ancients.

Now as to Authority, it is a sign of the most abject cowardice, to give infinite credit to Authors, but to deny its rights to Time, the author of all authors, and so of all Authority. For Truth is well called the daughter of Time, not of Authority. And so it is not wonderful that these spells of Antiquity, Authority and Consent, have so bound down the power of man that he cannot (being as it were bewitched) hold communication with things themselves.

85. Nor is it only the admiration of Antiquity, Authority, and Consent which has driven the industry of men to rest in present discoveries; but also it is admiration of the results themselves, which have already been furnished to the human race in great abundance. For when one has re-

viewed the variety of things, and the very beautiful apparatus which has been gathered together and introduced for civilised life by the Mechanical Arts, he will certainly be inclined rather to admire the wealth of man than to feel his poverty—nohow considering that the original observations of man, and operations of Nature (which are, as it were, the vital breath and first motive of all that variety) are neither many, nor drawn from any depth ; while all else belongs only to the patience of men, and the subtle and well-ordered motion of hand or instruments. For, (for example) the making of clocks is a subtle and accurate thing, seeing it seems to imitate things in the heavens by means of its wheels, and the pulses of animals by its successive and well-ordered motion; and yet it depends only on one or two Axioms of Nature.

But if, again, one looks into that subtilty which belongs to the Liberal Arts, or that which regards the preparation of natural bodies by Mechanical Arts, and things of this kind—as the discovery of Heavenly motions in Astronomy, of harmony in Music, of letters of the Alphabet (which even to this day are not in use in China) in Grammar: or again, in Mechanical matters, the deeds of Bacchus and Ceres; i. e. the making of wine and beer; the making of bread, or of delicacies for the table; distillations, and the like: he, too, if he reflects and considers how many revolutions of time (for, with exception of distillation, all these things are ancient) they have taken to reach that state of cultivation in which we now possess them; and (as has been already said of clocks) how little they owe to observations and Axioms of Nature; and how easily, and as it were by obvious occasions, and self-offering thoughts, they might have been discovered: he, I say, will easily free himself from all admiration, and rather will pity the condition of man, in that for so many ages there has been so great a dearth and barrenness of things and inventions. And even these discoveries which we have just mentioned were older than Philosophy and the intellectual arts; so that (if one must speak the truth) when rational and dogmatic sciences of this kind began, the discovery of useful works ceased.

Then if one turns from the workshops to the Libraries, and admires the immense variety we see of books, he, after the matter and contents of the books themselves have been examined and diligently inspected, will surely be astounded the other way; and after he has observed that there is no limit to repetitions, and to the way in which men do and say the same things, he will pass from admiration of variety to wonder at the want and fewness of those things which have hitherto held and occupied the minds of men.

Next, if one should condescend to look into those matters which are held to be more curious than sound, and should inspect somewhat closely the works of Alchemists or Magicians, he will perchance doubt whether these things are worthier of laughter or of tears. For the Alchemist cherishes eternal hope, and where he fails, arraigns his own errors as the cause; thinking in self-accusation that he has not sufficiently understood the words of his art or of his authors; whence he applies his mind to traditions and secret whispers; or he thinks he has slipped a little in the exact weights and minutiæ of his operation; whereupon he repeats experiments for ever: and meanwhile, when amidst the accidents of experiments he falls in with something whose appearance is new, or use not despicable, he feeds his mind with pledges of this kind, and boasts and magnifies them; for the rest he buoys himself up with hope. For it is not to be denied that Alchemists have discovered not a few things, and have enriched mankind with useful discoveries. But the fable of the old man suits well with them, who left to his sons a sum of gold buried in his vineyard (pretending that he had forgotten the exact spot); whereupon they took diligently to digging up the vineyard, and though no gold indeed was found, yet the vintage was made more fruitful through that tillage.

But the cultivators of Natural Magic, who explain everything by the sympathies of things, have feigned, with idle and most supine conjectures, virtues and admirable operations in things: and if ever they have shown any results, they have been such as are fitting for admiration and novelty, not for fruit and utility. Farther, in Superstitious Magic (if we must speak of it) we must consider this first—that it is only in subjects of some certain and definite kind, that curious and superstitious arts have had any power or play among all nations, in all ages and even over religions. And so we dismiss these. Meanwhile we need not marvel, that the belief in plenty has given rise to want.

86. The admiration, moreover, of men for teaching and Arts, simple enough and almost puerile in itself, has been increased by the cunning and artifice of those who have treated of and handed down the Sciences. For they put them forward before men's eyes with such ambition and affectation, and so fashioned, and as it were masked, that they seem to be quite perfected and carried through to the end. For if you regard their method and divisions, they appear to embrace and include everything which can fall into that subject. And although these be members ill filled out, and like empty book-shelves, yet they present to the vulgar Intellect the form and plan of a perfect Science.

But the first and most ancient inquirers into Truth, with greater fidelity and a better fate, were wont to throw that knowledge they minded to gather from the contemplation of things, and to store for use, into *Aphorisms* or short scattered unmethodical sentences: nor did they pretend or profess that they embraced an universal Art. But as things are now carried on, it is little marvel that men do not seek anything farther in those subjects, which are handed down as perfect, and as in all their parts long since completed.

87. Farther, the ancient systems have gained very much in consideration and credit from the vanity

and levity of those who have put forward the new; especially in the active and operative part of Natural Philosophy. For there have not been wanting men of vain tongues and fantastic, who partly from credulity, partly from imposture, have laden the human race with promises: ostentatiously promising prolongation of life, retarding of old age, alleviation of pain, restoration of natural defects, deceptions of the senses, restraint and incitements of the affections, illumination and exaltation of Intellectual faculties, transmutations of substances, strengthening and increasing of motions at will, impressions and changes of the air, bringing under our power celestial influences, divinations of the future, representations of things remote and past, revelations of things hidden, and many other such. But as to these bountiful people one would not be far wrong in judging of them, that in the doctrines of Philosophy there is as much difference between their vanities and the true arts, as there is in History between the exploits of Julius Cæsar, or Alexander the Great, and those of Amadis de Gaul or Arthur the Briton. For those most renowned generals are found to have performed in reality greater things than those shadowy heroes are even feigned to have done; but in manner and ways of action by no means fabulous or prodigious. Nor is it just to take away credit from true story, because it has been sometimes injured and violated by fables. But meanwhile, it is not at all wonderful, that great prejudice should arise against new propositions through those impostors who have attempted similar things; since the excess of vanity, and consequent disdain, have even now destroyed all nobleness of spirit in endeavours of this kind.

88. But far greater damage has been inflicted on the sciences by the littleness of mind, and smallness and shallowness of the tasks which human Industry has proposed to herself. And yet (worst of all) this littleness of mind does not manifest itself without arrogance and pride.

For first, there is that warning in all Arts, which is now become familiar, namely, that in every Art, the Authors turn the infirmity of theirs into a calumny against Nature; and what their Art cannot attain to, that by the same they pronounce to be impossible in Nature. Nor certainly can Art be condemned, if she be her own judge. Even the Philosophy which is now in men's hands nurtures in her own bosom certain positions or views whereby (if diligent inquiry be made) people wish mankind to be quite persuaded; namely, that nothing hard, or imperious and strong over Nature, ought to be expected from Art or work of man: even as was noticed above concerning the difference in kind between sidereal and other Heat, and concerning mixture. Now if these things be accurately noticed they altogether belong to a malicious circumscription of human power, and to a purposed and artificial despair, which not only disturbs the auguries of hope, but also cuts all the spurs and sinews of industry and casts away the chances of experience herself: for men are solicitous as to this alone, that their Art be reckoned perfect; seeking a most vain and abandoned glory from the doctrine, that whatever has not yet been discovered or comprehended, for the future must be believed to be entirely undiscoverable, and incomprehensible. And so if any one does try to betake himself to things and to discover something new, still he will determinately propose and fix for himself the investigation and bringing out of some one invention, and no more; as the Nature of the Magnet, the Tides, the System of the Heavens, and the like, which seem to have in them something secret, and up to this time have not been happily treated. Now it is the height of unskilfulness to investigate the Nature of any thing in itself; for the same Nature which in some things seems to be latent and occult, in others is manifest, and, as it were, tangible; and in the former rouses admiration, in the latter not even attention. As is the case in the nature of Consistency; it is not noticed in wood or stone, but is passed by with the name of Solidity, nor is any farther question raised as to the repulsion of separation, or the solution of continuity: but in water-bubbles the same thing seems to be subtle and delicate; for these bubbles throw themselves into pellicles, curiously taking the form of a Hemisphere, so as to avoid the solution of continuity for a moment.

But certainly those very things which are regarded as secret, have in some cases a plain and common Nature: this, however, will never be clear if the experiments or contemplations of men be engaged on these things alone. Generally however, and commonly, in Mechanical works it is regarded as a new discovery, if any one polishes subtly what has been long ago discovered, or adorns it elegantly, or unites and compounds things, or couples them more commodiously for use, or exhibits a work in greater or even less bulk and volume, than has been customary, and the like.

And so no marvel that noble discoveries, worthy of the human race, have not been brought to light, when men are contented and delighted with small and puerile tasks of this kind; and think too that they have followed, or have attained to, something great in the same.

89. Nor is it to be overlooked, that Natural Philosophy has in all ages had a troublesome and stubborn adversary in Superstition, and a blind and immoderate zeal for Religion. Thus it is to be seen among the Greeks, that they who first proposed to the yet unprepared ears of men the natural causes of lightning and tempests, were condemned, on that head, for impiety towards the Gods: nor were those much better received by some of the old Fathers of the Christian Religion, who laid it down from most sure demonstrations, such as no one in his senses could nowadays contradict, that the Earth is round, and asserted in consequence that there must be Antipodes. Farthermore; as things are now, the condition of discourses on Nature is made more severe, and more dangerous in consequence of the

summaries and methods of Scholastic Theologians; who while they have (as far as they could) reduced Theology into order, and have fashioned it into the form of an Art, have besides succeeded in mingling far more than was right of the quarrelsome and thorny Philosophy of Aristotle with the body of Religion.

The fictions, too, of those who have not feared to deduce and confirm from the principles and authority of Philosophers the truth of the Christian religion, have the same tendency, though in a different way. These celebrate the wedding of Faith and Sense, as though it were lawful, with much pomp and solemnity, and soothe the minds of men with a grateful variety of things, but meanwhile mingle the divine with the human in ill-matched state. And in mixtures like this of Theology with Philosophy, those things only which are now received in Philosophy are included: while novelties, though they be changes for the better, are all but banished and driven out.

Lastly, you may find, thanks to the unskilfulness of some Divines, the approach to any kind of Philosophy, however improved, entirely closed up. Some, indeed, in their simplicity are rather afraid, lest perhaps a deeper inquiry into Nature should penetrate beyond the allowed limits of sobriety; transferring and absurdly twisting those things which are spoken in the Sacred Scriptures, as to divine Mysteries, concerning those who pry into the secret things of God, to the hidden things of Nature, which are prohibited by no interdict. Others, more craftily, conjecture and consider that if the means be unknown, each single thing can be referred more easily to the hand and rod of God; a matter, as they think, of very great importance to religion: and this is nothing more nor less than wishing *to please God by a lie.* Others dread example, for fear the movements and changes of Philosophy should end by invading religion. Others, finally, seem anxious that nothing be found out in the investigation of Nature, which might (especially among the unlearned) subvert, or at any rate shake Religion.

But the two last causes for fear seem to us to smack of nothing but a carnal wisdom; as though men in the recesses of their mind, and in their inmost thoughts distrusted and had doubts about the firmness of Religion and the empire of Faith over sense; and for that reason feared danger to them from inquiry into the Truths of natural things. Whereas if one considers the matter rightly, Natural Philosophy is, after God's word, the surest medicine for Superstition, and also the most approved nourishment of Faith. And so she is rightly given to Religion as a most faithful handmaiden; the one manifesting the will of God, the other His power. Nor was he wrong who said, *Ye do err, not knowing the Scriptures, nor the power of God:* connecting and conjoining information as to His will with meditation on His power in indissoluble bonds. Meanwhile it is the less strange, if the growth of Natural Philosophy be restrained, since Religion, which has so much power over men's minds, has, through the unskilfulness and incautious zeal of some men, gone over and been hurried away into the contrary party.

90. Again, every thing is found to be adverse to the progress of learning in the habits and appointments of Schools, Academies, Colleges, and the like Institutions, which are set apart as seats of the learned, and for the culture of erudition. For lectures and exercises are so appointed, that it would not easily occur to any one to think of or to contemplate any thing out of the common. And if a chance man have ventured to use liberty of judgment, he may impose on himself alone this work, but will gain no advantage from communication with others. If he have even endured this, yet he will find this industry and nobleness of mind no small impediment to himself in making his fortune. For the pursuits of men in places of that kind are shut up in the writings of certain authors, as into prisons: and if any one dissents from them, forthwith he is seized as a turbulent man, and desirous of revolution. But surely there is vast difference between civil matters and the Arts: for there is not the same danger from new movements and from new light. In civil affairs even a change for the better is suspected as likely to cause disturbance; for civil affairs rest upon authority, consent, fame, and opinion, not on demonstration. But in Arts and Sciences, as in mines, all ought to resound with new works and farther progress. And this is so according to right reason, though meanwhile we practically do not

live according to it: but the administration of teaching and the polity of the Sciences of which we have spoken is wont rigorously to repress their growth.

91. And farthermore, even if this dislike had ceased, yet it is sufficient to restrain the growth of Sciences, that endeavours and industry of this kind have no rewards. For the cultivation of the Sciences and its reward are not in the power of the same persons. For the increase of Sciences proceeds, indeed, from great minds; while prizes and rewards are in the hands either of the vulgar or of princes, who (except very seldom) are but moderately learned. And farther, such progress lacks not merely the rewards and beneficence of men, but even popular praise: for it is above the grasp of the greatest part of men, and is easily overwhelmed and extinguished by the blasts of vulgar opinions. And so no wonder if that thing succeeds not happily, which is not had in honour.

92. But far the greatest obstacle to the progress of the Sciences, and the undertaking new tasks and provinces in the same, is found in the despair of men and the supposition of impossibility. For prudent and severe men are wont in matters of this kind to be utterly diffident, when they consider the obscurity of Nature, the shortness of life, the fallacies of the senses, the infirmity of judgment, the difficulty of experiments, and the like. And so they think that there are certain ebbs and flows of the Sciences in the revolutions of times and ages of the world; so that in some ages they grow and

flourish, in others decline and fall: so, however, that when they have reached a certain height and state, they can get no farther.

And so, if any one believes or promises greater things, they consider it a sign of an impotent and immature mind; and think that such endeavours have joyful beginnings indeed, but difficult continuance, and confused endings. And as thoughts of this kind are those which may readily enter the minds of men of gravity and excellence of judgment; care is truly to be taken lest being caught by the love of what is most good, most fair, we relax or lessen the severity of our judgment; and we must look diligently to see what Hope shines, and from what quarter; and after rejection of the more feeble glimmerings of Hope, those things are to be carefully tried and weighed which seem to have in them greater stability. Nay more, civil prudence is to be called in and consulted, which doubts by rule, and conjectures for the worse in human affairs. And so we must now speak also concerning Hope: especially as we are no vain promisers, nor offer violence, nor lay snares for the judgment of men, but lead men by the hand and of their own accord. And although it will be far the most powerful remedy for the establishing of Hope, when we lead men to particulars, especially as digested and disposed in our Tables of Inventions (which belong partly to the Second, but much more to the Fourth division of our Instauration); since this is not merely Hope, but as it were the thing itself: yet in order that things may be done more smoothly, we must proceed in our determined plan of preparing men's minds; this unfolding of preparation is no small part of Hope. For without it, every thing else tends more to sadden men (so as to give them a worse and viler opinion of things now in use than they have already; and a deeper feeling and knowledge of the misfortune of their own condition) than to produce any briskness or to sharpen men's industry for experiment. And so our conjectures, which make Hope probable in this matter, are to be unfolded and propounded: as Columbus did before his wonderful voyage across the Atlantic; when he produced reasons why he believed new lands and continents might be discovered besides those which were heretofore known: and these reasons, though at first rejected, were yet afterwards proved by trial, and were the causes and outset of the greatest events.

93. Let us begin from God, and shew that our present work, on account of the excellent nature of Good in Him, is manifestly from Him; who is the Author of Good, and Father of lights. But in divine operations all even the most slender beginnings produce fruit: and what is said of spiritual matters, that "The Kingdom of God cometh not with observation," is also found to be the case in every greater work of Providence: all things glide on placidly without noise and sound; and the matter is achieved before men think or consider that it is being done. Neither is the Prophecy of Daniel concerning the last times of the world to be omitted:

"Many shall run to and fro, and knowledge shall be increased;" clearly hinting and signifying that it is in the Fates, i. e. in Providence, that the circumnavigation of the world, (which through so many lengthy voyages seems to be entirely completed or to be in course of completion,) and the increase of the sciences should happen in the same age.

94. There follows the strongest reason of all for Hope; viz. from the errors of times past, and of the ways as yet tried. For that was a most excellent rebuke which one addressed to a state ill-administered in the following words; "That which was worst in the past, ought to seem best for the future. For if you had rightly ordered all things which pertain unto your duty, and still your affairs had been in no better case; then surely there had been no hope left of the possibility of improvement. But as the state of your affairs is bad, not from the force of circumstances, but from your own errors, it is to be hoped, that after dismissal or correction of these errors, there can be a great change of things for the better." Similarly, if men for the space of so many years had held to the true way of discovering and cultivating the Sciences, and yet had not been able to make any farther progress; the opinion that any farther advance is possible would be doubtless rash and reckless. But if men have mistaken their road, and labour has been wasted on those things in which it certainly ought not to have been; it follows thence, that the difficulty does not arise in things themselves, which are not in our power; but in the

human Intellect, and its use and application; a thing which admits of remedy and cure. And so it will be the best plan to have put forward these very errors; for there are as many arguments for Hope in the Future, as there have been impediments from Error in the Past. And although these points have not been entirely untouched in the earlier part of the Book, yet it seems good to represent them here again in bare and simple language.

95. They who have handled the Sciences have been either Empirics or Dogmatists. The Empirics, ~~like the~~ Ant, amass only and use: the latter, like ~~Spiders, spin~~ webs out of themselves: but the course of the Bee lies midway; she gathers materials from the flowers of the garden and the field; and then by her own power turns and digests them. Nor is the true labour of Philosophy unlike hers: it does not depend entirely or even chiefly on the strength of the mind, nor does it store up in the memory the materials provided by Natural History and Mechanical Experiments unaltered, but changes and digests them by the Intellect. And so from the closer and holier league of these faculties, (the experimental and the rational)—which have not been connected—good hopes are to be entertained.

96. Natural Philosophy is not yet found to be sincere, but is infected and corrupted: in Aristotle's school by Logic; in Plato's by Natural Theology; in Plato's second school, (that of Proclus and others,) by Mathematics; which ought to give bounds to Natural Philosophy, not to generate or procreate it.

But better things are to be hoped from a pure and unmixed Natural Philosophy.

97. No one has yet been found of so great constancy and sternness of mind, as to have determined and set it as a task to himself, utterly to abolish common theories and conceptions, and to apply afresh to particulars an Intellect cleared and levelled. And so that human Reason which we possess is a kind of farrago and gathering of much credulity, much chance, and the boyish conceptions which we first imbibed.

But if any one in his ripe age, with his senses whole and his mind purified, should apply himself anew to experience and particulars, we should have better hopes for him. And on this point we promise ourselves the fortune of Alexander the Great: and let no man accuse us of vanity before he hears the upshot of the matter; for its tendency is towards the putting off of all vanity. For Æschines spoke of Alexander and his deeds as follows: "Surely we live no mortal life; but are born for this, that posterity may relate and publish our prodigies." Just as if he had considered Alexander's deeds a miracle. But in following ages Livy considered and saw into the matter more truly; and spoke much as follows of Alexander "That he did nothing beyond justly daring to despise what was vain." And we conceive that a similar judgment will in future times be passed on us also: "That we did nothing great; but only made less of those things which were regarded as great." But meanwhile (as we said just now) there is no hope save in the Regeneration of Sciences; they must be raised up and rearranged by experience in fixed order: and this no one (in our opinion) will affirm has as yet been done or even thought of.

98. The foundations of experience (for we must certainly come down to this point) have hitherto either been non-existent, or very infirm; nor has store or material of particulars either in quantity, kind, or certainty fit to inform the Intellect, or in any way sufficient, hitherto been sought out and collected. But on the contrary learned men (idle truly and easy folk) have accepted for the formation or confirmation of their Philosophy, sundry rumours reports and breaths of experience, and have attributed to these the weight of legitimate testimony. And just as if some kingdom or state governed its counsels and its business, not by the letters and despatches forwarded to it by its Ambassadors and trustworthy Messengers, but by the small-talk and gossip of the streets; so have the affairs of Philosophy been administered, as far as experience goes. Nothing in Natural History is found to be duly investigated, nothing verified, nothing numbered up, nothing weighed, nothing measured. And what is in observation indefinite and vague, the same in information is deceitful and unfaithful. If these things seem strange sayings to any one, and not far removed from unjust complaint;—seeing that Aristotle, a man of such powers, and supported by the wealth of so great a King, has completed so accurate a History

of Animals; and some others with greater diligence, (though with less noise,) have added much thereto: and again others have written copious histories and narrations of plants, metals, and fossils;—he does not seem to attend sufficiently and to see into what is going on at present. For there is one kind of Natural History, which is made for its own sake; another kind which is gathered for the information of the Intellect in order to the building up of Philosophy. And these two kinds of History differ on other points indeed, but specially in this; that the former of them contains the various natural species, the latter the experiments of Mechanical Arts. For just as in civil affairs the abilities of each man, and the secret sense of his mind and affections are better drawn forth in positions of disturbance than elsewhere; similarly the hidden things of Nature more betray themselves when the Arts provoke them, than when they wander on in their own course. And so we then shall have good Hope for Natural Philosophy after Natural History, which is its base and foundation, has been better arranged;—till then no Hope at all.

99. And again; in the very abundance of Mechanical Experiments, the utter poverty of those which make most for and assist the information of the Intellect is discovered. For the Mechanician, nohow solicitous about the inquiry into Truth, neither raises his mind nor stretches forth a hand to anything which does not subserve his own work. But then shall Hope of the farther progress of the sciences be well founded, when there shall be received and

gathered into Natural History a multitude of experiments, which in themselves are of no use, but avail only for the discovery of causes and axioms. These we are wont to call *Light-bringing* experiments, to distinguish them from *Fruit-bearing* ones. They have in them a wonderful virtue and condition; namely, they never deceive or disappoint. For as they are employed not to effect any result, but to reveal the natural cause in something, in whatever way they fall out, they equally satisfy our purpose, as they settle the question.

100. But not only is a greater abundance of experiments to be sought for and procured, and of another kind too from those hitherto gathered; but also an entirely different Method, Arrangement, and Process are to be introduced for the continuation and promotion of experience. For vague experience, which follows only itself, (as has been said above,) is a mere groping, which stupifies men rather than informs them. But when experience shall proceed under a fixed Law, in due series and sequence, then we may have better Hopes for the sciences.

101. But after collection and preparation of such abundance and material of Natural History and Experience as is requisite for the work of the Intellect or for any philosophical work, still the Intellect is in no way sufficient to act spontaneously and by bare aid of memory upon those materials; one might just as well hope to be able to retain in memory and to know by heart the computation of an Almanack. And yet up to this time meditation

has done more in discovery than writing has; nor as yet has a "Literate Experience" been collected: and yet except by writing no discovery is to be approved. When however it comes into use, we may hope better things from Experience when it has at length become Literate.

102. And farthermore, when there is so great a number and host of particulars, and these too so scattered and diffused as to disconnect and confuse the Intellect; no good Hopes can be entertained from the skirmishings, light movements, and transitions of the Intellect; unless there be an arrangement and marshalling of those things which pertain to the subject on which we are making inquiry, by means of fit, well arranged, and, as it were, living Tables of Discovery; and unless the mind be applied to the prepared and digested assistance afforded by these Tables.

103. But we must not forthwith pass from the abundance of particulars duly and orderly placed under our eyes, to inquiry into and discovery of new particulars, or effects; or at any rate, if this be done, we must not rest there. We do not deny that after collection and digest of all experiments of all arts, and after these have come to the knowledge and judgment of one man, many new things may be discovered, useful for human life and condition, by transferring the experiments of one art to others, by means of that Experience, which we call Literate: still, less things are to be hoped for from it, and greater things from the new light of Axioms,

educed by certain way and rule out of those particulars, which in their turn may indicate and mark out new particulars. For the road does not lie on a level; but ascends and descends—ascending first to Axioms, descending to Effects.

104. Nor, however, can it be allowable for the Intellect to leap and fly from particulars to remote, and (in name) most general Axioms, (such as are what they call "the principles of Arts and Things,") and by means of their (supposed) immoveable Truth to prove and make out intermediate Axioms. This is the process followed hitherto, thanks to the proneness of the natural impulse of the Intellect to this, and to its being accustomed and trained to it, by means of Syllogistic Demonstrations. But then we may hope well for the Sciences, when ascent is made by the true ladder, by successive steps, not interrupted or broken, from particulars to lesser Axioms, thence to intermediate ones, one over another, and lastly, in due time, to the most general. The lowest Axioms differ but little from bare experience. And those highest and most general Axioms (as now considered) are conceptional and abstract, and have in them no solidity. But the middle ones are the true, solid, living Axioms, whereon depend man's affairs and fortunes; and above these, at last, are those really most general; these however are not abstract, but truly bounded by the intermediate ones.

And so we must not add wings, but weights and lead, to the Intellect, so as to hinder all leaping and flying. And this has not hitherto been done: when it has been, we shall be allowed to entertain better Hopes for the Sciences.

105. Moreover, in forming an Axiom, a form of *Induction*, different from that hitherto in use, must be thought out; and this, too, not only for testing and discovering principles (as they call them), but also for lesser, then for intermediate, and finally for all Axioms. For that Induction which proceeds by simple enumeration is a puerile thing, and concludes uncertainly, and is exposed to danger from any contradictory instance, and for the most part pronounces from fewer instances than it ought, and of these only from such as are at hand. But the Induction which will be useful for the discovery and demonstrations of Sciences and Arts, ought to separate Nature by due rejections and exclusions; and then, after a sufficient number of negatives, to conclude upon affirmatives; a thing which hitherto has not been done, nor indeed attempted, save only by Plato, who for the formation of Definitions and Ideas certainly uses this form of Induction up to a certain point. But for the good and legitimate appointing of this Induction or Demonstration, very many things are to be made use of which have as yet entered into the thoughts of no man; so that more labour must be spent upon it than has hitherto been spent upon the Syllogism. And the assistance of this Induction must be had not only to discover Axioms, but to limit conceptions also. And on this Induction depends our greatest Hope.

106. Now in establishing Axioms by means of

this Induction, examination and proof are also to be made use of; whether the Axiom being established be only fitted and made to the measure of those particulars out of which it is extracted, or whether it is more extensive and broader. For if it be more extensive or broader, we must see whether it confirms its extent and breadth by designation of new particulars, using them as a kind of bail—lest we should either only stick at what is already known, or perhaps with too loose a grasp, should seize hold of shadows only and abstract forms, not at what is solid, and limited in matter. As soon as these tests come into operation, then at length a steady light of Hope will have shone forth upon us.

107. And here too we must resume what was before stated concerning Natural Philosophy carried out, and concerning the bringing back particular sciences to it, so that there should be no cutting and maiming of sciences; for without this, too, there is but little progress to be hoped for.

108. Now we have spoken enough for the removing of despair and the creation of Hope, from bidding farewell to or rectifying the errors of time past. Let us also see if there be any other grounds of Hope. And first, this strikes one—if men who were not seeking for them, but were engaged in something else, have nevertheless found out many useful discoveries, by some chance or circumstance; no one can doubt that men, if they did seek for them, and engage themselves upon them, and that too methodically and orderly, not by fits and starts

and desultorily, would necessarily discover far more things. For though it may happen once and again that any one has hit upon that by chance which hitherto had escaped him, though he sought it with great effort and diligence, yet generally the contrary is doubtless the case. And so, far more and better things, and at less intervals, are to be hoped from man's reason and industry, direct method and application, than from chance, and animal instinct, and the like, which up to this time have originated discoveries.

109. It may also be taken as a ground for Hope, that some of those things which have already been discovered, are of such a kind that, before they were discovered it could not have come readily into any one's mind to suspect any thing about them; but one would clearly have treated them with contempt as impossibilities. For men are wont to prognosticate about innovations by the example of things known of old, and by the measure of the fancy taught and vitiated by them; a kind of anticipation most fallacious, since much that is derived from the springs of things, flows not through the accustomed channels. As if, before the discovery of Cannon, one had described the thing by its effects; and had spoken as follows: "A certain discovery has been made, by which walls, and fortifications of whatever size can be shaken and cast down from a great distance;" then certainly men would have been likely to think of multiplying the powers of engines and machines, by means of weights, wheels, battering-rams,

and similar projectiles; but it scarcely could have ever occurred to any one's imagination or fancy to think of a fiery wind expanding and breathing forth so suddenly and violently; for he could not have seen an example of it at hand, unless it were perhaps in earthquakes or lightning, which men would forthwith have rejected as the great operations of Nature, and as not imitable by man.

In the same way, if, before the discovery of Silk, any one had discoursed as follows: "There is a certain kind of thread discovered, useful for garments and furniture, which far exceeds thread of linen or of wool in fineness, and at the same time in strength, beauty, and softness;" men would directly have begun to imagine something about a kind of cotton, or about the more delicate hair of some animal, or the feathers and down of some birds; whereas they certainly would have conjectured nothing about the spinnings of a puny worm, so copious, so self-renewing, and annual. And if any one had offered a word about a worm, he would certainly have been laughed at for dreaming about new spiders' webs.

Similarly, if, before the discovery of the Needle, one had thus discoursed; "There is discovered a certain instrument, by means of which the quarters and points of the heavens may be accurately taken and discerned;" men would straightway have run off with the workings of fancy, after many and divers thoughts as to the more exquisite making of Astronomical Instruments; but that any thing could be discovered, whose motion agreed so well with that of the celestial bodies, and yet was itself not celestial, but only stone or metal—this would have seemed utterly incredible. And yet these things and the like have escaped men's notice for very many ages of the world, nor were discovered through Philosophy or Arts of reason, but accidentally and by chance; and are (as we said) of such a kind as to be quite heterogeneous and most removed from any thing before known; so that no previous conception would have been of any avail in leading to them.

And so one may quite hope that there are many things of excellent use still hidden in Nature's bosom which have no kindred or parallelism with what has been already discovered; but are altogether placed out of the ways of fancy; which as yet, anyhow, are undiscovered; which doubtless after many circuits and turnings of ages will at some time come forth, as those above mentioned have done; but which, by the way we are now treating of, can be both represented and anticipated speedily, suddenly, and together.

110. Farthermore, there are to be seen other discoveries also of a kind to create a belief that the human race can pass by and leap over noble discoveries, even when they are lying before their feet. For however the discoveries of Gunpowder, Silk, the Needle, Sugar, Paper, or the like, seem to depend on certain properties of things and of Nature; still certainly the art of Printing has in it nothing but what is clear and almost obvious. And yet men, from not considering that though type is certainly more

difficult to put together than letters are to write by motion of the hand, yet there is this difference, that type once arranged can be used for an infinite number of impressions, whereas letters written by hand serve only for one copy; or perhaps, from not observing that ink may be made so thick as to tinge without flowing—(needed as the letters face upwards, and the impression is made from above)—have for so many ages been without this most beautiful discovery which is of so great value for the propagation of learning.

Moreover, the human mind, in this course of discovery, is wont to be so giddy often and so ill regulated, that it first distrusts, and then soon despises itself; and first it seems incredible to it that any such discovery should be made; and then, after it has been made, it seems again incredible that it could have escaped men's notice for so long a time. And this very thing is fairly drawn to be a ground of Hope: namely, that there remains yet a mighty heap of discoveries, which can be brought out by means of the Literate Experience of which we have spoken, not only by the investigation of unknown operations, but also by the transfer, composition, and application of things already known.

111. Nor is this to be omitted as a ground of Hope. Let men consider the infinite expenditure of talent, time, and fortune, which men lavish on things and studies of far less use and price; of which if only a little part were turned to sane and solid matters, there is no difficulty which

could not be overcome. And this we have thought it right to add, because we plainly confess, that the collection of a natural and experimental History, such as we trace out in our mind, and such as there ought to be, is a great work, and almost regal, and one requiring much labour and cost.

112. Meanwhile let no man fear the multitude of particulars, but rather make ground of Hope even of this. For the particular Phænomena of the Arts and Nature are but a handful compared with the fictions of the wit after they have been disjoined and abstracted from the evidence of things. And the outlet of this road is in the open country, and almost at hand; the other hath no outlet, but is an infinite maze. For men have hitherto made little stay with experience, and have touched on it but lightly, while they have spent infinite time on the meditations and fictions of the wit. With us, however, if there were any one at hand to answer to our questions concerning the facts of Nature, the discovery of all Causes and Sciences would be a matter of but a few years.

113. And something of Hope may also be afforded to men from my own example. Nor do I say this for boasting's sake; but because it is profitable to be said. If any lack confidence, let him regard me, a man of all men of my age most occupied with civil affairs, and of but infirm health (a thing most wasteful of time); one too who in this matter am clearly a pioneer, and have followed no man's footsteps, nor have considered these matters in company

with any; and yet let him see how I, having entered with constancy upon the true way, and submitted my wit to facts, have (as I think) carried these matters some way forward: and then let him see what is to be expected, after these my hints and guidance, from men of abundant leisure, from combination of labour, from succession of ages; especially in this way, which is not only possible for individuals (as that way is which depends on the Reason) but wherein the labours and results of men (especially as far as regards the collection of experience) may be best distributed and then combined. For men will begin to know their own strength when each provides his own part of the work, not every man the same.

114. Lastly, even though a far weaker and fainter breeze of Hope blew from this new Continent, yet we are resolved to make the attempt, unless we would wish to be of an utterly dastard spirit. For the risks of not attempting and of not succeeding are anything but equal—in not attempting, we risk a mighty good; in not succeeding, only a little human labour is expended. But, from what has been said, and even from what has not, it seems to us, that there is great sufficiency of Hope not only for an active man to make the trial, but also for a prudent and sober man to believe in its success.

115. And now we have spoken of the removal of despair, one of the most potent causes of the delay and restraint of the progress of the Sciences: and at the same time we have completed our discourse

on the signs and causes of the errors, sloth, and ignorance which have prevailed; especially as the more subtle causes, which do not fall under the judgment or observation of the multitude, ought to be referred to what has been said respecting the Phantoms of the Human Mind.

And here, at the same time, the destructive portion of our *Instauration* ought to be concluded. This is perfected in three confutations; namely, the confutation of *human Reason*, natural and left to itself; the confutation of *Demonstrations;* and the confutation of *Theories*, or of received systems of Philosophy and teaching. The confutation of these has been such as it could be—that is, by means of signs and evidence of causes; since no other kind could be used by us, as we dissent from others both on first principles and in method of Demonstration.

Wherefore it is now time for us to come to the very Art and Rule for *the Interpretation of Nature:* and yet there remains a something, which must first be noticed. For as it is our purpose in this first Book of Aphorisms, to prepare the minds of men as much for the understanding as for the reception of what follows; the platform of the mind being now cleared, smoothed and levelled, it remains for us to place it in a good position, and, as it were, with a friendly aspect towards what we shall propound. For in a new matter prejudice is caused not only by our being strongly preoccupied by an old opinion, but also by a false anticipation or prepossession as to the thing adduced. And so we will endeavour that good and true opinions be held as to what we advance, even though it be for a time only, and, as it were, laid out at interest, until the matter itself be thoroughly known.

116. First, then, we must beg men not to think that we, like the ancient Greeks, or certain moderns, Telesio, Patrizio or Severino, are wishing to found some Philosophical sect; for neither do we do this, nor even do we think it signifies much for men's fortunes, what abstract opinions each may hold as to Nature, and the principles of things: nor is it to be doubted that many old things of this kind might be recalled, and many new introduced, just as many hypotheses of the Heavens may be supposed, which, though they agree sufficiently well with the Phenomena, yet differ from one another.

But we do not trouble ourselves with matters of this kind—matters of opinion, and at the same time of no practical use. On the contrary we are determined to try whether we cannot lay the foundations of human power and dignity more firmly, and extend its boundaries more widely. And although dispersedly and in some special subjects we have things more true, more certain (as we believe), and even more fruitful than those which men as yet have made use of; (we have gathered them into the fifth part of our *Instauration;*) yet we propound no universal or complete Theory. For the time for so doing does not seem to be yet come. Nor do we expect to live to complete the sixth part of the *Instauration* (which is destined for a Philosophy discovered by lawful Interpretation of Nature); but we hold it sufficient if we proceed soberly and usefully in the intermediate part, and meanwhile scatter for posterity seeds of a more sincere Truth, and be not wanting to the commencement of so great matters.

117. But as we are no founders of a Sect, so we are not going to be prodigals or promisers of particular effects. And yet some one may thus object—that we, who so often make mention of effects, and draw all things that way, ought ourselves to exhibit some as pledges. But our way and plan (as we have often said clearly, and are ready to repeat) is this; not to extract effects from effects, or experiments from experiments, (as the Empirics do,) but, as rightful Interpreters of Nature, to produce causes and axioms from effects and experiments, and then from those causes and axioms new effects and experiments. And although in our Tables of Discovery (of which the Fourth Part of our *Instauration* consists) and also in our examples of Particulars (which we have introduced in the Second Part), and farther, in our observations upon History (described in the Third Part of our work) any man of ordinary intelligence and ability will every where perceive indications and sketches of many noble effects; yet we frankly confess, that the Natural History we already have, either from books or our own inquiries, is not so copious or so well verified as to satisfy or minister to a lawful Interpretation.

And so, if any one be more fitted and prepared for Mechanical pursuits, and sagacious in hunting out effects, because he is versed only in experiments, to him we give up and relinquish the industry of plucking and applying to practical use many things from our History and Tables, as from the wayside, and of so receiving interest for a time until the principal can be obtained. But we, as we reach forward to greater things, condemn all hasty and premature delay in matters of this kind, according to our favourite illustration from Atalanta's apples. For we do not, like children, desire the golden apples, but rely wholly upon Nature for the victory in the race of Art; nor do we hasten to reap moss or the green crop, but wait for the harvest in due season.

118. Doubtless it will also occur to some one, after he has read through our History and Tables of Discovery, that there is in the experiments themselves something uncertain, or altogether false; and he will perhaps for that reason think that our discoveries rest on false and doubtful foundations and principles. But this is nothing: for it is necessary that such things should happen at first. For it is just as if in writing or printing some one or two letters were wrongly placed, separately or together; —this is not wont to offer much hinderance to the reader, as the errors are easily corrected by sense. So too let men think that many experiments in Natural History can be falsely believed and received; and that these are soon easily expunged and rejected when causes and axioms have been discovered. Yet

it is true, that if in Natural History and experiments there were great, frequent, and continual errors, they could not be corrected or emended by any happiness of Wit or Art. And so, if in our Natural History, collected and proved with so great diligence, severity, and almost religious scruple, any thing false or erroneous should at any time be lurking in particulars; what will be to be said about the ordinary Natural History, which before ours was so negligent and easy? what of the Philosophy and Sciences built up on its sands—or rather its quicksands? And so let this difficulty we have mentioned move no one.

119. Again; many things will be found in our History and experiments, first trivial and ordinary, then mean and illiberal, lastly too subtle and merely speculative, and seemingly of no use: things which may turn aside and alienate the good will of men.

But let men think this of those things which seem ordinary—that they truly are as yet wont to do nothing but refer and accommodate the causes of rare things to those which frequently occur: while they do not seek for any cause of those things which frequently happen, but receive them as things conceded and admitted.

And so they seek no causes of Weight, Rotation of the Heavenly bodies, Heat, Cold, Light, Hardness, Softness, Rarity, Density, Liquidity, Solidity, the Animate and the Inanimate, Like and Unlike, or even Organic Formation; but first receive them for evident and manifest things, and then dispute and decide about matters which do not occur so frequently and familiarly.

But we, who well enough know that no judgment can be formed as to rare or notable things, much less that new things can be brought to light, without proper examination and discovery of the causes of ordinary things, and of the causes of causes, are necessarily driven to receive the most ordinary things into our History. And farther; we find that nothing has caused more harm to Philosophy, than that things which are familiar and of frequent occurrence do not delay and detain men's thoughts, but are taken as matters of course, nor are their causes usually sought for: so that attention to well known things is as often required as information concerning things unknown.

120. Next, as regards the meanness, or even foulness of things, which (as Pliny says) require an apology; these, no less than things most beautiful and costly, are to be received into Natural History. For Natural History is not polluted thereby—the Sun enters alike into the Palace and the Sewer, but is not thereby polluted. But we are not dedicating or building any Capitol or Pyramid to human Pride, but found a holy temple in the human Intellect, on the model of the Universe. And so we follow our model. For whatever is worthy of Existence is worthy of Knowledge—which is the Image (or Echo) of Existence. Now the vile exists as well as the splendid. And more—even as from some putrid matters, as musk or civet, most excellent odours are

sometimes generated; so too the finest light and information emanate sometimes from vile and sordid instances. But of this we have said too much; for this kind of niceness is clearly puerile and effeminate.

121. But the next is in every way to be looked into more accurately; namely, that many things in our History will seem to the ordinary apprehension, and even to any Intellect accustomed to things as they now are, to be of some curious and useless subtilty. And so we have spoken and must speak of this before all things. We say that we, now at the beginning and for a time, seek only *Light-bringing* not *Fruit-bearing* experiments; after the example of the Divine Creation, as we have often said, which on the first day produced Light only, and to it assigned one whole day, nor on that day added any thing of material work.

And so, if any one thinks things of this kind are of no value, it is as though he thought there was no value in the Light, because it is not a solid or material thing. And in truth we must say, that the knowledge of simple Natures when well examined and defined is like Light: for it affords an approach to all the recesses of effects, and by some power it embraces and draws after it whole bands and troops of effects, and fountains of most noble Axioms; though in itself it is not of so great use. Just so the elements of letters taken separately by themselves are of no significance or use; but yet they are a prime material for the composition and preparation of all discourse. Even the seeds of things, potentially strong, are of no use except in their growth. And the scattered rays of Light itself, unless they combine, do not impart their benefit.

And if any one be offended by these speculative subtilties, what shall be said of the Schoolmen, who indulged to such excess in subtilties? And these subtilties were spent on words, or at any rate on vulgar conceptions, (which comes to the same thing,) not on things or Nature; and were devoid of utility, not ✓ only in origin, but also in their consequences; nor were they such as to have for the present no utility, but in their consequences infinite benefit, which is the case with those of which we speak. But let men know this for certain, that all subtilty of disputations and reasoning, if it be only introduced after the discovery of Axioms, is too late and behindhand; and that the true and proper, or at any rate the chief time for subtilty, is at the balancing of experience, and then in the laying down of Axioms: for that other subtilty snatches at and tries to seize Nature, but never apprehends or takes her. And certainly what is said of Opportunity or Fortune is most true also if it be transferred to Nature—"She wears a lock in front, but behind she is bald."

Finally, as to the contempt, in Natural History, of things either common, or mean, or too subtle, and useless in their beginnings, let the words of the poor woman to a haughty prince, who was for throwing aside her petition as a thing unworthy, and beneath his majesty, be taken for an oracle—"Cease then to be a king;"—for it is most sure that the empire over Nature can never be won or kept by any one who is unwilling to pay heed to matters of this kind, as being too small and trifling.

122. Another objection is this: that it is something wonderful and hard, that we should at once, and by one blow and assault, drive out all Sciences and all Authors: and that without taking any of the Ancients to assist and guard us, but, as it were, by our own strength alone.

But we know that, had we been willing to act with less sincerity and good faith, it would not have been difficult for us to have referred what we bring forward, either to the ancient ages before the times of the Greeks, (when natural Sciences flourished perhaps more, though more silently, before they had fallen in with the trumpets and fifes of the Greeks,) or even (in parts at least) to some of the Greeks themselves; and thence to have sought authority and honour: just like men of no family, who, through the favours of Genealogies build up and feign for themselves a nobility from some ancient line. But we, relying on the evidence of things, reject every condition of lying and imposture; nor do we think it of any greater consequence to our subject, whether what shall now be discovered was formerly known to the Ancients, and has been setting and rising with the changes and periods of things, than whether the New World be the Island of Atlantis, and known to the Old World, or now for the first time discovered. For the discovery of things is to be sought from the

Light of Nature, not to be resought from shades of Antiquity.

But as regards that universal censure we have pronounced, it is most certain, if one truly considers the matter, that it is both more probable and more modest than if it had been only partial. For if the errors had not been rooted in first conceptions, some things when rightly discovered must necessarily have corrected those ill-discovered. But when errors are fundamental, and of such a kind that men have neglected and passed over things rather than formed a bad or false judgment respecting them, it is little marvel if they have not obtained what they did not seek; have not arrived at the goal, which they did not set up; have not completed a course which they never entered nor held to. And as to the presumption of the thing; certainly if any one were to pretend that by firmness of hand and vigour of eye he could describe a straighter line or a more perfect circle than any one else could, then there would be introduced a comparison of abilities: but if any one assert that he, by application of a ruler or compass, can describe a straighter line, or more perfect circle than any one else can by means of hand and eye alone; this man certainly would not be very much of a boaster. This does not refer only to our first and introductory attempt, but also to those who hereafter shall labour at this subject. But our method of discovery of Sciences nearly levels men's wits, and does not leave much to their excellence: since it transacts everything by most sure rules and demonstrations. And so this method of ours (as we have often said) comes rather from some good fortune than from ability, and is the offspring of Time rather than of Wit. For surely there is Chance as much in human thought, as in human works and deeds.

123. And so we must say of ourselves what one said jesting—especially as it hits the matter so well:—that water-drinkers and wine-drinkers cannot think alike. For all men hitherto, ancient or modern, have in learning drunk but a crude liquor like water, which has either flowed of its own accord from the Intellect, or has been drawn up, as by wheels out of a well, by means of Logic. But we drink and pledge others with a liquor made of many well-ripened and mature grapes, gathered and plucked from particular clusters; then pressed in the wine-press; and lastly cleansed and clarified in a vessel. And so no marvel that we and others do not agree.

124. Doubtless this will be another objection; that the true and best goal and scope of Sciences is not first laid down by ourselves, the very fault for which we blame others. For that the contemplation of Truth is worthier and higher than any utility and magnitude of effects: but that this long and anxious delay over experience and matter, and the billows of particulars, fastens the mind to the ground, or rather casts it down into some Tartarus of confusion and disturbance; and debars and removes it from the serenity and tranquillity of abstract wisdom, as from some far more godlike state. But we readily assent to this reasoning; and chiefly and

before all things are engaged on this very subject which is pointed at and especially desired. For we are founding in the human Intellect a true pattern of the Universe; such as it is actually found to be, not such as any one's own reason may have suggested it to him. But this cannot be completed, save after a most diligent dissection and anatomy of the world. We declare that those foolish models, and as it were apish imitations of worlds, which men's fancies have erected in their systems of Philosophy, are to be scattered to the winds. And so let men know, as we said above, what a difference there is between the Phantoms of the human Mind, and the Ideas of the Divine Mind. The former are nothing but fanciful abstractions: the latter are the true signatures of the Creator upon creatures, as they are impressed and limited in matter by real and exquisite lines. And so the chief things of all are, in this kind, Truth and Usefulness; and effects themselves are to be accounted of more worth, in so far as they are pledges of truth, than as they give the comforts of life.

125. The following too may perhaps be objected: that we only repeat what has been already done; that the Ancients themselves trod the same path as we do. And so any one will think it probable that after so much movement and toil, we too shall at last arrive at some one of those systems of Philosophy, which prevailed among the Ancients. For they in the beginning of their meditations prepared a great store and plenty of examples and particulars;

and digested them by heads and titles into Common-place Books; and then composed their systems and Arts, and afterwards, when all was complete, decided; and added now and then some examples to confirm and throw light on their doctrine, but thought it waste of time and trouble to publish their notes of particulars, minutes, and Common-place Books; just as is wont to be done in building; after the edifice is finished, men remove out of sight their scaffolding and ladders. Nor indeed ought we to believe that they did otherwise. But unless any one have utterly forgotten what has been said above, an easy answer can be made to this objection, or rather to this scruple. For we ourselves allow that the Ancients had a form of inquiry and discovery; as too their writings plainly shew. But this was just the plan of leaping from some examples and particulars (with the addition of common conceptions and perhaps of some portion of received opinions, which they may like best) to the most general conclusions, or principles of the Sciences; from whose unshaken and fixed Truth they deduced and proved lower conclusions by means of intermediate Propositions; and out of these composed their Art. Finally, if new particulars and examples were put forth and produced, which contradicted their views, these they subtly reduced into order either by means of distinctions or explanations of their own rules; or lastly, got them out of the way in the lump as exceptions; while they laboriously and steadily accommodated the causes of particulars which did not contradict them to those principles. But that was neither such a Natural History nor experience as ought to have been—far from it;—and that flying off to most general Axioms ruined all.

126. Another objection: that we, through our forbidding Dogmatism, and the laying down determinate principles, until we have properly arrived by means of the middle steps to the most general Truths, are favouring a kind of suspension of judgment, and are leading to Scepticism. But we do not think of and propose Scepticism, (*Acatalepsia,*) but its contrary (*Eucatalepsia*)*;* for we do not derogate from the honour due to the senses, but minister to them; the Intellect we do not despise, but regulate. And it is better to know what is needful, and to think that we do not know every thing, than to think we know every thing, and yet to know none of those things that are needful.

127. Again: some one will doubt rather than object; whether we speak of perfecting by our method Natural Philosophy only, or the other Sciences as well, Logic, Ethics, Politics. But we certainly understand that what we have said refers to all: and just as the common Logic which rules Things by means of Syllogism pertains not only to natural Sciences, but to all; so ours too, which proceeds by Induction, embraces all things. For we construct a History and Tables of Discovery as much of Anger, Fear, Modesty, and the like; or of the examples of civil affairs; and no less of the mental emotions of Memory, of Composition and Division, Judgment

and the rest; as of Cold and Heat, Light, or Vegetation, or the like. But however, since our method of *Interpretation*, after due preparation and arrangement of History, looks not only into the motions and processes of Mind, (as does common Logic,) but also into the Nature of Things; we so regulate the mind that it may be able to apply itself to the Nature of Things, by methods apt in all cases. And for this cause we give many and diverse precepts in our doctrine of *Interpretation*, which may apply in some measure a means of discovery to the quality and condition of the subject which we are investigating.

128. The following, however, it is not right for any one to feel even a doubt about; viz. whether we desire to destroy and demolish Philosophy, and the Arts and Sciences, which we use: for on the contrary, we gladly embrace their use, culture, and honours. For we nohow would hinder those which have prevailed from both nourishing disputations, adorning discourse, being applied and prevailing for professional use and service of civil life; or from being, finally, received among men by consent, like coin. And more,—we plainly signify that what we adduce will not be very fit for such subjects, as it cannot at all be reduced to the comprehension of the vulgar, save only by its effects and resultant works. But how honestly we profess what we say concerning an affection and good-will towards the received Sciences, our writings already published (especially the treatise on the Advancement of Learning) do shew. And so we will no farther

endeavour to convince by words. Meanwhile we constantly and explicitly give warning, that by the usual methods neither can great progress be made in the doctrines and contemplations of the Sciences, nor can they be carried out to any magnitude of results.

129. It remains for us to say a little as to the excellence of the end. This, had it been said earlier, might have seemed only empty wishes; but now that Hope has been raised, and unfair prejudices removed, it will perhaps have more weight. And if we had ourselves entirely perfected and discharged all things, without proceeding to call in others to take their share and part in our labours; even then we should have abstained from such language, lest it should be regarded as a setting forth of our own merit. But as the industry of others has to be sharpened, and their minds to be roused and kindled, it is fitting we should recal some things to men's recollections.

First, then, the introduction of noble discoveries seems to hold by far the highest place among human actions: and so Antiquity judged: for it paid Divine honours to discoverers; while to those who had done good deeds in civil affairs (as the founders of cities and empires, legislators, liberators of their native land from long-continued ills, subverters of tyrannies, and the like) they only decreed the honours of Heroes. And certainly, if one rightly compares them, he will find this judgment of Antiquity to be just. The benefits of discoveries can pertain to all the race of man; civil benefits only to certain seats of men: these latter do not endure beyond a few ages; the former, as it were, for ever. And the amendment of civil estate proceeds for the most part not without violence and disturbance; while discoveries bless, and produce their benefit without injury or sorrow to any one.

Again, discoveries are a kind of new creations, and imitations of Divine works, as he has well sung who wrote,

> Athens, a glorious name, the first of old
> Gave birth to fruitful Arts, for suffering man;
> She new-created Life, and founded Laws.
>
> Lucret. vi. 1.

And it seems worthy of notice in Solomon, that though he flourished in extent of empire, gold, magnificence of works, in his attendants and servants, his fleet, the renown of his name, and the highest admiration of men, yet chose none of these things as his glory, but declared that "it is the glory of God to conceal a thing: but the honour of Kings is to search out a matter."

Again, if you please, let any one consider what an immense difference there is between man's life in any highly cultivated part of Europe and in some very wild and barbarous region of the new Indies: he will think they differ so much that it may rightly be said that "one man is a God unto another," not only for aid and advantage, but also on comparison of conditions. And this not the soil, not the climate, not bodily powers, but the Arts provide.

Again, it is worth while to notice the force, virtue, and consequences of discoveries. And these appear more manifestly in none than in those three, unknown to the Ancients, and whose origin, although recent, is obscure and inglorious: Printing, Gunpowder, and the Needle. For these three have changed the face and state of things in all the world: the first, in letters, the second, in war, the third, in navigation. And from them have followed changes innumerable; so that no empire, no sect, no star seems to have exercised a greater command and influence over human affairs than have these mechanical discoveries.

Moreover, it will not be foreign to our purpose to distinguish off three kinds and degrees of human Ambition. The first, that of those who desire to increase their own power in their country: a vulgar and degenerate sort. The second, that of those who strive to augment the power and rule of their country among mankind: this sort has certainly more dignity, but no less cupidity. But if one endeavours to renew and enlarge the power and empire of the human race itself over the Universe, this Ambition doubtless (if such it is to be called) is sounder and more august than the rest. Now the empire of man over things is founded on the Arts and Sciences only; for Nature is only governed by obedience.

Besides, if the utility of any one particular discovery has so affected mankind, as to make us think that he who could oblige the whole human race with any benefit must be greater than man; ~~how much higher will it~~ seem to discover some method by means of which all other things may be rapidly discovered! And yet (to speak the truth) just as we are very thankful to Light which enables us to enter on our way, exercise Arts, read, distinguish one another, and yet the seeing Light is itself more excellent and fair than its many uses are: so certainly the contemplation of things as they are, without superstition or imposture, error or confusion, is in itself more worthy than all the fruit of discoveries.

Finally, if any object that Sciences and Arts are degraded to wickedness, luxury, and the like; let not this disturb any one. For this can be said of all earthly goods, of Wit, Bravery, Strength, Beauty, Wealth, Light itself, and the rest. Only let man regain his right over Nature, which belongs to him by the gift of God; let there be given to him the power: right reason and sound religion will teach him how to apply it.

130. But now it is time we should propound our Art of *Interpreting* Nature; and although we think we have given the most useful and truest precepts concerning it, still we do not attribute to it an absolute necessity, as though nothing could be done without it; or even do we count it complete. For we are of this opinion; that if men had at hand a just History of Nature and experience, and employed themselves upon it diligently, and could command themselves in two things; first, to lay aside received

opinions and conceptions; secondly, to restrain their minds, for a time, from the most general Axioms, and those nearest to them: then even by the natural and genuine power of their minds, and without any Art, they would fall into our form of *Interpretation*. For *Interpretation* is the true and natural work of the mind, after obstacles have been removed: yet, certainly, through our precepts, all things will be more in readiness and far more firm.

Nor do we assert that nothing can be added to this; but on the contrary, we, who regard the mind not only in its own powers, but as it is coupled with things, ought to hold that the Art of Discovery can grow together with Discovery itself.

APHORISMS

ON

THE INTERPRETATION OF NATURE

OR

THE REIGN OF MAN.

BOOK THE SECOND.

1. UPON a given body to generate and superinduce a new Nature or new Natures is the work and aim of Human Power. To discover the Form of a given Nature, or its true Difference, or its causal Nature, or fount of its emanation (for these are the Terms in use which most nearly indicate the thing we mean)—this is the work and aim of Human Knowledge. And under these primary operations must be put two others, secondary and of a lower stamp. Under the former the transformation of concrete bodies from one into another, within the limits of possibility: under the latter the discovery in all generation and motion of the *Latent Process* which goes on without break from the

manifest Efficient, and Matter, up to the inward Form; and in like manner, the discovery of the *Latent Conformation* of bodies in rest, not in motion.

2. The unhappy case of Human Knowledge, as it is now, is even manifested by what is ordinarily asserted. It is rightly laid down that "true knowledge is knowledge by causes." Also the establishment of four Causes is not bad: Material, Formal, Efficient, Final. Of these, however, the Final Cause is so far from profiting us, that it even corrupts Knowledge, except in Morals. The discovery of Form is held to be hopeless. And the Efficient and Material Causes (such as are now sought for and received, i. e. those remote from, and without *Latent Process* towards Form) are slovenly and superficial, and of scarcely any avail for true and active Knowledge. Nor have we forgotten how we above noticed and corrected the error of the human mind in assigning to Forms the first qualities of Essence. For although in Nature nothing really exists except individual bodies, which produce individual pure acts according to Law: yet in science, that Law itself and the investigation, discovery, and unfolding thereof are the foundation both of knowledge and of practice. This *Law*, then, *and its Paragraphs* we mean when we speak of Forms; especially as this word has grown into common use, and is of familiar occurrence.

3. His Knowledge is imperfect, who knows the cause of any Nature (Whiteness, for example, or Heat) only in certain subjects: His Power likewise

is imperfect, who can induce the effect only upon certain materials (among those which are capable of it). And he who knows only the Efficient and Material Causes, (which are variable, and nothing more than vehicles, and causes conveying Form in some substances,) can arrive at new discoveries in such Matter as is to some extent of one kind and previously prepared: but he does not move the limits of things more deeply fixed. Whilst he who knows Forms embraces the Unity of Nature in most dissimilar materials; and so can disclose and produce things which as yet have not been done, such as neither the changes of Nature, nor industry in experiment, nor even chance itself would ever have brought into action, and such as would never have entered the thoughts of man. Wherefore from the discovery of Forms follow both true contemplation and free operation.

4. Although the ways to human Power and Knowledge be most nearly joined, and almost the same; yet in consequence of the pernicious and inveterate habit of dwelling upon abstractions, it is decidedly safer to begin and to raise the sciences from those foundations which are laid with reference to practice, and to let it (practice) mark and limit the part of contemplation. And so when we want to generate or superinduce any Nature upon a given body, we must see what precept, or what direction or guide anyone would most desire; and this too in simple language, without abstruseness.

For example; suppose a person wishes to superinduce upon Silver the yellow colour of Gold; or an additional weight (the laws of the material being observed); or transparency on an opaque stone; or tenacity on glass; or vegetation on a body which is not vegetable. We must see (I say) what kind of precept or guide this person would most prefer. And first, he will doubtless especially desire something to be shewn him which may not fail in effect, or deceive him in trial. Secondly, he will greatly desire something to be prescribed which shall not bind and restrict him to certain means, and particular methods of operation. For he will perhaps be at a loss, and not have either power or opportunity of obtaining such means. While if there be other means and methods (beside those laid down) of producing such a nature, there may perhaps be some among them which are in the power of the agent; from which, however, he will be excluded by the narrowness of the precept, and will take thence no fruit. Thirdly, he will desire something to be shewn him which may not be so difficult as that operation he is seeking, but may approach more nearly to practice.

And so this shall be laid down concerning the true and perfect rule of practice—*that it be certain, free, and disposing, or in the way towards action.* And this is the very same thing as the discovery of true Form. For the Form of any Nature is such that, if it be there, the given Nature infallibly follows. And so it is always present when that Nature is present, and universally affirms its presence, and is inherent in the whole of it. The same Form is such that, if it be removed, the given Nature infallibly vanishes. And so it is always absent, when that Nature is absent, and always affirms such absence, and exists in that Nature only. Lastly, the true Form is such as to produce the given Nature from some fountain of Essence existing in more subjects than one, and "notior est naturæ," as the phrase is, than Form itself. And so this is our dictum and rule respecting a true and perfect Axiom for knowledge—*that a Nature be found convertible ~~with a given~~ Nature, and yet such as to be a limit of a more noscible Nature, ~~like a real~~ Genus.* And these two rules, the practical and the contemplative, are the same thing; and what is most useful for practice is also most true for knowledge.

5. The precept or Axiom as to the transformation of ~~bodies is~~ of two kinds. The first regards a body as a troop or combination of simple Natures. So in Gold the following meet; it is yellow; heavy and of a certain weight; malleable, or ductile in certain extension; it is not volatile, and loses none of its quantity by fire; it melts in a certain manner; it is separated and solved in certain ways: and so similarly of the rest of the Natures which meet in Gold. And so an Axiom of this kind brings out the thing from the Forms of simple Natures. For he who knows the Forms and methods of superinducing yellowness, weight, ductility, stability, melting, solution, and the rest, and their gradations and methods, will see and take care that these may be joined toge-

ther in some body, whence may ensue a transformation into Gold. And this kind of operation belongs to primary action. For the plan of generating some one simple Nature is the same as that for generating many: except that man is more confined and restricted in operation if many be required, in consequence of the difficulty of uniting so many Natures, which do not combine readily, except through the worn and usual paths of Nature. It must however be observed that this method of operation (which regards simple Natures, although in a concrete body) proceeds from what is in Nature constant, eternal, catholic: and affords such broad paths for human Power, as (as things now are) man's thoughts can scarcely comprehend or imagine.

The second kind of Axiom (which depends on the discovery of the *Latent Process*) does not proceed by simple Natures, but by concrete bodies, (as they are found in Nature,) by the usual course. E. g. such is the case when we ask from what beginnings, in what manner, by what process, Gold or any other metal or stone is generated, from its menstruum or rudiments up to the perfect mineral; or similarly by what process herbs are generated, from the first concretions of juices in the earth, or from seeds, up to the formed plant, with all the succession of motion, and different and unbroken efforts of Nature; similarly of the generation of animals regularly unfolded, from coition to birth: and similarly of other bodies.

Farthermore, this inquiry looks not only to the generations of bodies, but to other motions and labours of Nature. E.g. This is the case when we make inquiry as to the universal series and continued actions of the nutritive process, from the first reception of food to its perfect assimilation; or similarly, as to voluntary motion in animals, from the first impression of the imagination, and the continued efforts of the spirit, to the bending and movements of the limbs; or as to the free motion of tongue, lips, and other instruments unto the uttering of articulate sounds. For these too refer to concrete, or collected Natures, in their growth; and regard as it were particular and special habits of Nature, not the fundamental and common Laws which constitute Forms. Yet it must be certainly ~~allowed that this plan~~ seems more expeditious, and closer at hand; and produces ~~more hope than~~ the first-mentioned one does.

Similarly, the operative branch, which answers to this contemplative branch, extends and pushes on its operation from those things which are ordinarily discovered in Nature, to other subjects most nearly connected, or not far removed from them; while the deeper and radical operations of Nature depend entirely on primary Axioms. Moreover, even where man has not the means of acting, but only of knowing, as in Astronomy (for it is not granted man to operate on the Heavenly Bodies, or to change or transform them) yet there the investigation of facts or of the Truth of the matter, no less than the cognisance of causes and agreements, is referred to the primary and catholic Axioms concerning simple

Natures—such as the Nature of spontaneous rotation, of Attraction or the Magnetic Force, and many other things which are more common than things Heavenly. For no one is to hope to determine the question as to whether in the Diurnal Motion it is really the Earth or the Heaven that rotates, until he has first comprehended the Nature of spontaneous rotation.

6. The *Latent Process* of which we speak is not at all a thing which, as men's minds are now occupied, can easily occur to them. For we mean not certain measures, or symptoms, or degrees of process, perceptible in the bodies themselves: but simply a continual process which for the most part escapes the observation of the senses.

E. g. In all generation and transformation of bodies, inquiry must be made as to what is lost and evaporates; what remains; what is added; what dilatation or contraction takes place; what union or separation; what continuance or rupture; what impulsion or obstruction; what is powerful and what weak; and many other such.

Nor here again are these things to be sought for only in the generation or transformation of bodies; but in all other alterations and motions also similar inquiry must be made, as to what precedes, and what follows; what is quicker, what more slow; what produces and what regulates Motion; and the like. All these matters are unknown to and untouched by the Sciences, (which are now fabricated in the heaviest and most incapable manner). For, as all natural action is carried on through the smallest spaces possible, or at any rate through those which are too small to strike the senses; let no one hope that he can rule or turn Nature, unless he has duly comprehended and observed these.

7. Similarly, the Investigation and Discovery of the *Latent Structure* in bodies is a new thing; no less so than the discovery of the *Latent Process* and of Form. For as yet we clearly tread only the outer courts of Nature, and prepare no approach to her inner chambers. No one can endow a given body with a new Nature, or happily and appositely transmute it into a new body, unless he has a good knowledge of the body to be changed or transformed. For he will run into vain methods, or at any rate into difficult and perverse ones, and not fitted for the Nature of the body on which he is operating. And so a way is thoroughly to be opened and paved towards this point also.

And on the Anatomy of organic bodies (such as those of man or animals) labour is surely rightly and usefully bestowed, and seems to be both a subtle thing and a good search into Nature. This kind of Anatomy is perceptible, and subject to the senses, and has its place only in organic bodies. And truly it is a something obvious, and of ready access, in comparison with the true Anatomy of *Latent Structure* in bodies which are regarded as similar; especially in things of the same species and their parts, as iron and stone; and in the similar parts of a plant, or an animal, as the root, the leaf, the flower; the flesh, the blood, the bone, &c. Yet human industry has not entirely failed even in this kind of Anatomy, for the separation of similar bodies by means of distillation and other methods of solution, so that the dissimilarity of the compound may appear through the gathering together of the homogeneous parts, tends this way. And this is of use, and makes for what we are seeking; though for the most part it is a fallacious thing; because many Natures are reckoned and attributed to the separated bodies as if they previously existed in the compound; though in truth it was fire and heat and other methods of separation which have newly introduced and superinduced them. But even this is but a small part of the work, with a view to the discovery of the true *Structure* in a compound; which *Structure* is a thing far more subtle and accurate, and is rather confused by the operations of fire than extracted and brought to shew itself.

And so a separation and solution of bodies is to be made; not indeed by fire, but by reason and true *Induction*, with auxiliary experiments; and by means of the comparison of other bodies, and reduction to simple Natures, and their Forms, which meet and are woven together in the compound; and one must just pass from Vulcan to Minerva, if it be in our mind to bring to light the true textures and *Structures* of bodies, on which every occult and (as they call it) specific property and virtue in things depends, and whence too every rule for effectual alteration and transformation is drawn.

E. g. We must inquire what *Spirit* there is in every body; and what *Tangible Essence:* and as to that *Spirit*, whether it be copious and exuberant; or meagre and scarce; subtle or more dense; more aerial or igneous; sharp or sluggish; thin or stout; progressive or retrograde; abrupt or continuous; agreeing or disagreeing with external and surrounding circumstances, &c. And in like manner as to *Tangible Essence* (which admits of no fewer differences than *Spirit* does), and of its hair, its fibre, its texture of all kinds. Again, the position of the *Spirit* through the corporeal mass, its pores, passages, veins, cells, and rudiments or first essays of the organic body, fall under the same head of inquiry. But on these too, and so in every kind of discovery of *Latent Structure*, true and clear light is shed by primary Axioms, which certainly scatter all clouds and subtle difficulties.

8. Nor by this are we brought to the (Epicurean) Atom, which presupposes a Vacuum, and Matter immutable (both of which are false), but to true Particles, as they are found to be. Nor again is there anything for anyone to be horrified at in this subtilty, as though it were inexplicable; but on the contrary, the more our inquiry tends towards simple Natures, the more all things will be clear and perspicuous; when the matter is transferred from the manifold to the simple; from the incommensurable to the commensurable; from the "surd" to the "rational;" from the indefinite and vague to the definite and certain; as is the case with the elements

of Letters, and the simple notes which make up harmonies. And the Investigation of Nature goes on best when Physics are limited by Mathematics. Again, let no one dread the multitude or the fractions of things. For in matters of calculation it is as easy to lay down or to conceive a Thousand as an Unit; or the thousandth part of an Unit as an Unit itself.

9. From the two kinds of Axioms laid down above, arises a true division of Philosophy, and of the Sciences; if those received Terms, which most nearly approach to our meaning, be transferred to our sense. Namely, let the inquiry into Forms, which are (in reason at any rate, and after their own Law) eternal and immoveable, constitute *Metaphysics;* let the inquiry after the Efficient and Material causes, after the *Latent Process* and *Structure,* all of which regard the common and ordinary course of Nature, not its fundamental and eternal Laws, constitute *Physics:* and to these in like manner let two practical divisions be subordinate; to *Physics Mechanics,* to *Metaphysics Magic* (in a purified sense of the Term), because of its broad ways and wider dominion over Nature.

10. Thus the aim of our teaching having been laid down, we must go on to its precepts: and that too in an order as little deranged and disturbed as possible. And our hints for the *Interpretation of Nature* embrace two parts differing in kind; the first is on the eliciting or producing Axioms from experience: the second, on the deducing or de-

riving new experiments from Axioms. The former part is divided into three Ministrations; the Ministration to the Senses, the Ministration to the Memory, and the Ministration to the Mind or Reason.

For first, a *Natural and Experimental History* must be prepared, sufficient and good; for this is the basis of the whole thing: for we must not fancy nor think out, but must discover what Nature does or endures.

But *Natural and Experimental History* is so varied and scattered as to confound and distract the intellect, unless it be fixed and appear in due order. And so *Tables*, and *Coordinations of Instances* are to be formed in such a manner and with such arrangement, that the Intellect may be able to act upon them.

And even though this be done; yet the Intellect, if left to itself and acting spontaneously, is incompetent and unequal to the task of constructing Axioms, unless it be regulated and directed. And so, in the third place, legitimate and true *Induction*, the very key of Interpretation, is to be applied. And moreover we must begin at the end, and travel backwards to the rest.

II. The Investigation of Forms proceeds thus: in the case of a given Nature we must first make a *Presentation to the Intellect* of all known *Instances* which agree in having this same Nature in materials even the most unlike. And a collection of this kind must be made historically, and without too hasty contemplation, or any too great subtilty. E.g. take the Investigation of the Form of Heat.

Instances agreeing in having the Form of Heat.

i. The Sun's Rays, especially in Summer and at Noon.

ii. The Sun's Rays reflected and combined, as between mountains, or along walls of houses, and specially in burning-glasses.

iii. Ignited Meteors.

iv. Burning Lightning.

v. Eruptions of Flames from the Cavities of Mountains, &c.

vi. All Flame.

vii. Ignited Solids.

viii. Natural Hot Baths.

ix. Warm or heated Liquids.

x. Warm Vapours and Smoke, and the Air itself, which admits a most powerful and raging heat, if confined; as in Reverberatories.

xi. Some fine Weather, arising from the constitution of the Air itself, without respect to the time of year.

xii. Confined and subterraneous Air in some caverns, especially in the Winter.

xiii. All shaggy substances, as Wool, Hides, Plumage, have some warmth.

xiv. All bodies, solid as well as liquid, dense as well as rare (like the Air itself), placed near fire for a time.

xv. Sparks from Flint and Steel gotten by sharp percussion.

xvi. All bodies rubbed violently, as Stone, Wood, Cloth, &c.; so that poles of carriages, and axles, sometimes catch fire: and the way the West Indians obtain fire is by attrition.

xvii. Green and moist vegetable matter confined and pressed together, as Roses, Peas in baskets; so that Hay if it be damp when stacked often catches fire.

xviii. Quicklime, slaked with water.

xix. Iron when it is first dissolved by aqua fortis in glass, and that too without putting it near fire: similarly with Tin, &c. but not so intensely.

xx. Animals, especially and always internally; though in Insects the Heat is not detected by the touch in consequence of the smallness of their bodies.

xxi. Horsedung, and like fresh excrement of Animals.

xxii. Strong Oil of Sulphur and of Vitriol follows the operation of Heat in burning linen.

xxiii. Oil of Marjoram, and of like substances, follow the operation of Heat in burning bones.

xxiv. Strong and well-rectified Spirit of Wine follows the operation of Heat: so that if white of egg be cast into it, it grows hard and white, almost in the same way as when boiled; bread thrown into it becomes parched and crusted, like toast.

xxv. Aromatic substances, and warm plants, as the Dracunculus, the old Nasturtium, &c., though to the hand they be not hot, neither when whole or powdered, yet to the tongue and palate, if chewed a little, they are felt to be hot, and almost burning.

xxvi. Strong Vinegar, and all Acids, on any part of the body where there is no epidermis—as in the eye, on the tongue, or any wounded part, or where the skin is removed,—cause pain, not much unlike that produced by Heat.

xxvii. Even severe and intense cold produces a kind of sensation of burning;

Nam Boreæ penetrabile frigus adurit.

xxviii. Other Instances.

This we are wont to call a *Table of Existence and Presence.*

12. Secondly; we must make a *Presentation to the Intellect* of *Instances* which are without the given Nature: because Form, (as we have said,) ought no less to be absent where the given Nature is absent, than to be present where it is present. But this would be an infinite task if we took every Instance.

And so we must class the *Negatives* under the *Affirmatives*, and the want of the given Nature must be investigated only in those subjects which are most cognate to those in which the given Nature is present and manifest. This we are wont to call a *Table of Declination*, or of *Absence in Proximate Instances*.

Proximate Instances, wanting the Nature of Heat.

First Negative Instance subjunctive to the First Affirmative.

i. The Rays of the Moon, the Stars, and Comets, are not found hot to the touch: nay, rather, the severest cold is usually observed at Full Moon.

But the larger Fixed Stars, when the sun passes under them or approaches them, are thought to increase and intensify the warmth of the Sun; as is the case when the Sun is in the Sign of the Lion, and in the Dogdays.

First Negative subjunctive to the Second Affirmative.

ii. The Sun's Rays in the middle region of the Air (as they call it) give no Heat; the commonly given reason for which is not bad, viz. that that region neither approaches near enough to the Body of Sun, whence the Rays emanate, nor on the other hand near enough to the Earth, whence they are reflected. And this is manifested by the tops of mountains, (unless they are exceedingly high,) where the snow is perpetual. On the other hand, it has been noticed by some that on the summit of the Peak of Teneriffe, and also on the Andes of Peru, the summits of the mountains are devoid of snow; the snow lying only lower on the sides. And the Air on those very summits of the mountains is found to be by no means cold, only rarified and sharp; so much so that on the Andes it pricks and wounds the eyes by its excessive sharpness, and excites also the orifice of the stomach, and induces vomiting. And it has been observed by the Ancients that the air was so rarified on the summit of Olympus, that it was necessary for those who ascended thither to carry with them sponges moistened with vinegar and water, and to apply them from time to time to their mouth and nostrils: because the air through its rarity was not sufficient for respiration. And it is also told that on that summit the serenity and absence of rain, snow, and winds was such, that when men were sacrificing there, letters traced with the finger in the ashes of sacrifices on Jove's altar remained quite undisturbed till the next year. And even at this day men who climb to the top of the Peak of Teneriffe do it by night and not by day; and soon after sunrise are warned and roused by their guides to make haste and descend, on account of the danger (as it seems) from the rarity of the atmosphere, lest it should hinder their breathing and suffocate them.

Second Negative to the Second.

iii. The reflection of the Sun's Rays, in the regions near the Polar circles, is found to be very weak and lacking in power of producing Heat: so that the Dutch, who wintered in Nova Zembla, and expected the liberation and disentanglement of their ship from the mass of ice which had blocked it up, about the beginning of July were disappointed of their hope, and were compelled to take to boat. And so the direct Rays of the Sun seem to have but little power even upon a level surface; nor even after reflection, unless they be multiplied and united, which takes place when the Sun approaches nearer to the Perpendicular; because then the incidence of the Rays makes acuter angles (with the reflection), so that the lines of the Rays are nearer to one another: while, on the other hand, when the Sun is in a very oblique position, its angles are very obtuse, and consequently the lines of the Rays farther apart. But meanwhile it is to be noted that there can be many operations of the Sun's Rays, and those too of the nature of Heat, which are not fitted for our sense of touch: so that though in respect to us they do not cause heat, yet with respect to some other bodies they may have the power of producing it.

Third Negative to the Second.

iv. Let an experiment of this kind be made. Take a Lens made concave instead of convex like Burning Glasses; place it between the hand and the Sun's Rays; and observe whether it diminishes the Heat of the Sun, as the Burning Glass increases and intensifies it. For it is manifest with regard to Visual Rays, that according as a Lens is made of unequal thickness in respect to its middle and its sides, so do images appear larger or smaller. And so the same thing must be looked after in Heat.

Fourth Negative to the Second.

v. Let diligent experiment be made, as to whether the Rays of the Moon can be caught and collected so as to produce any even the least degree of Heat, by means of Burning Glasses of the greatest strength and best make. If that degree of Heat be perchance too slight and weak to be perceived and appreciated by the sense of Touch, we must betake ourselves to those Glasses which mark the warm or cold condition of the air; so that the Moon's Rays fall through the Burning Glass, and be cast upon the top of a Glass of this kind; and then let observation be taken as to whether there is any depression of the water through Heat.

Fifth Negative to the Second.

vi. Let also the Burning Glass be tried on warm substances which throw out no rays nor light; as, on Iron or Stone heated but not ignited; or on Hot Water, or the like; and let observation be taken as to whether there is any increase and intensity of Heat, as in the case of the Sun's Rays.

Sixth Negative to the Second.

vii. Also let the Burning Glass be tried upon common Flame.

Negative to the Third.

viii. The effect of Comets (if one may number them also among Meteors) is not found to be constant or manifest in increasing the Heat of a year, although droughts have been very often noticed as following them. Moreover, Beams, Columns of light, Aurora Borealis, and the like, appear more often in Winter than in Summer; and most of all in time of most intense cold, when it is joined with dry weather. And yet Lightning, Flashes, and Thunder rarely happen in Winter, but at the time of great Heat. While Falling Stars, as they are called, are thought by the vulgar to be composed of some bright and inflamed viscous substance, rather than to be of a stronger fiery Nature. But on this point let farther inquiry be made.

Negative to the Fourth.

ix. There are some Coruscations which afford Light, but do not burn: but these are always unaccompanied by Thunder.

Negative to the Fifth.

x. Eructations and eruptions of flame are found as much in cold regions as in hot; as in Iceland and Greenland: just as also trees in cold regions are sometimes more inflammable, more pitchy and resinous, than in hot regions; as is the case in the Fir, the Pine, and the rest. But sufficient inquiry has not been made into the position and the nature of the soil in which eruptions of this kind are wont to take place, to allow of our subjoining a Negative to this Affirmative.

To the Sixth.

xi. All flame is always hot, more or less; and so there is no *Negative* subjoined to this at all. And yet they say that the Ignis Fatuus, as they call it, which sometimes lights upon a wall, has no great Heat; perhaps it is like the flame of Spirits of Wine, which is gentle and mild. And still more mild does that flame seem to be, which in some trustworthy and honest Histories is found to have appeared around the heads and hair of boys and virgins; for it did not at all singe their hair, but softly played around it. And it is most certain that some coruscation without manifest Heat has sometimes appeared round horses sweating in their journey by night in fine weather. And a few years ago—it is a well known fact, and almost regarded as a miracle—a Girl's Apron when a little shaken and rubbed produced sparks. This however might have been caused by Alum or Salt on the Apron, which stuck to it perhaps as an incrustation, and then was broken off by the rubbing. And it is most certain, that all sugar, candied or simple, so long as it is rather hard, if broken or scraped with a knife in the dark, emits sparks. Similarly sea water is sometimes found by night, when struck by oars, to sparkle. And even in storms the foam of the sea mightily agitated sparkles by night: and this sparkling the Spaniards call "the Sea's Lungs." But sufficient inquiry has not been made into that flame which the sailors of old called "Castor and Pollux," the moderns "Saint Elmo's fire," as to the quantity of Heat it contains.

To the Seventh.

xii. Every thing ignited so as to be turned into a fiery redness, is always hot even without flame; nor is there a *Negative* subjoined to this *Affirmative.* But that which seems to be most like one is Rotten Wood, which shines by night, and yet is not found to be hot; and putrefying Fish scales, which also shine by night, and yet are not found to be hot to the touch; nor is the body of the Glowworm, nor of that fly they call *Lucciola* found hot to the touch.

To the Eighth.

xiii. Sufficient inquiry has not been made into Hot Baths, as to the position and nature of the soil in which they are wont to burst forth. And so there is no *Negative* subjoined.

Negative to the Ninth.

xiv. As *Negative* to warm liquids is subjoined the proper nature of Liquid itself. For there is found no tangible Liquid which is in its own Nature hot and constantly remains so; but Heat is superinduced for a time only, as an adventitious Nature; so that those things which in power and operation are hottest, as Spirit of Wine, chemical Aromatic Oils, even Oil of Vitriol and Sulphur, and the like, which after a while burn, are cold to the touch at first. The water of natural Hot Baths, too, if taken in a vessel and separated from its source, loses Heat just like heated water. But it is true that oily bodies are a little less cold to the touch than watery ones; as oil is less so than water, silk less so than linen. But this belongs to the *Table of Degrees* of Cold.

First Negative to the Tenth.

xv. Similarly as *Negative* to hot Vapour is subjoined the Nature of Vapour itself, as it is found among us. Farther, exhalations from oily substances, though easily kindled, are not found to be hot, unless they have been recently exhaled from a hot body.

Second Negative to the Tenth.

xvi. Similarly as *Negative* to hot Air itself is subjoined the Nature of Air itself. For Air is not found among us to be hot, unless it be either confined or under friction, or clearly heated by sun, fire, or any other hot body.

Negative to the Eleventh.

xvii. Here is subjoined as *Negative* the case of Weather colder than for the time of year, when the East or North wind blows among us; just as contrary Weather occurs when South or Westerly winds blow. Also an inclination towards rain (especially in Winter) accompanies warm Weather; while on the other hand frost accompanies cold Weather.

Negative to the Twelfth.

xviii. To this is subjoined as *Negative* the case of Air confined in caverns in Summer. But we must altogether make more diligent inquiry into confined Air. For first, doubt arises, not without cause, as to what is the Nature of Air, as regards Heat and Cold, in its own proper Nature. For Air clearly receives Heat from the impression of Heavenly bodies; and Cold perhaps from the evaporation of the Earth; and again in the mid region of the Air (as they call it) from cold vapours and snow; so that no judgment can be come to as to the Nature of Air by means of the Air which is out of doors, and under the open sky, but a truer judgment might be formed by means of Air confined. But, moreover, it is needful the Air be confined in such a vessel and material as shall neither by its own power imbue it with Heat or Cold, nor easily admit the influence of outer Air. And so let the experiment be made with an earthen jar, wrapped round with many folds of leather to defend it from the external Air; and let the Air be kept in this vessel well closed, for three or four days. Then on opening the vessel the result may be taken either by hand or by application of a Thermometer duly graduated.

Negative to the Thirteenth.

xix. There is a similar doubt as to whether the warmth in Wool, Skins, Feathers, &c. arises from some slight inherent Heat, caused by their being the outward growth of animals, or from some fatness and oiliness, which may be of a Nature agreeing with warmth; or simply from the confinement and separation of Air of which we spoke in the last Article. For all Air seems, if cut off from the external Air, to have in it some warmth. And so let experiment be made on fibrous substances which are made of Flax; not on those made of Wool, Feathers, Silk, which are animal products. Also it is to be noted that all powders, (in which Air is clearly enclosed,) are less cold than the bodies before they are pulverised; just, too, as we think that all froth (as containing Air) is less cold than the liquid it comes from.

To the Fourteenth.

xx. To this no *Negative* is subjoined. For there is nothing found among us either tangible or 'Spiritual' which if put to the fire does not receive Heat. Things differ, however, in this, that some receive Heat more rapidly, as Air, Oil, Water; others more slowly, as Stone and Metals. But this belongs to the Table of Degrees.

Negative to the Fifteenth.

xxi. To this Instance is only subjoined the following as *Negative*, viz. that it be well noted, that sparks are not struck from Flint and Steel, or any other hard substance, except when some particles are struck out of the substance of the stone or metal; and that Air under friction never of itself generates sparks, as men commonly think; and besides, that these sparks themselves, through the weight of the ignited body, tend downwards rather than upwards, and on extinction return into a dark kind of corporeal ash.

To the Sixteenth.

xxii. We think that no *Negative* is subjoined to this Instance. For no tangible body is found among men, which does not clearly grow hot under friction; so much so that the Ancients used to dream that the Heavenly bodies had in them no other power or virtue of generating Heat, except through friction of the Air by rapid and violent rotation. But in this kind we must make farther inquiry as to whether bodies, cast forth from machines—as balls from cannon—do not contract some degree of Heat from the percussion itself; so that after they have fallen they are found somewhat hot. But Air in motion cools rather than heats; as in winds, bellows, and the blowing from the mouth when it is contracted. But motion of this kind is not so rapid as to excite Heat; and acts according to the whole; not through particles: so that no wonder it does not generate Heat.

To the Seventeenth.

xxiii. About this Instance more diligent inquiry must be made. For Herbs and green and moist Vegetation seem to have in themselves some occult Heat. But this Heat is so slight that it is not perceptible in each by touch: but after they have been gathered and confined, so that their spirit does not get out into the Air, but rather gathers warmth; then arises manifest Heat, and sometimes flame in material fit for it.

To the Eighteenth.

xxiv. About this Instance, too, more diligent inquiry must be made. For Quicklime, if water be scattered over it, conceives Heat; either because of the union of Heat, which before was scattered (as was before said of Herbs when confined) or because of the irritation and exasperation of the fiery spirit by the water, so as to cause a kind of conflict and struggle (Antiperistasis). But whichever the cause may be, it will appear more readily if instead of water oil be used. For oil will be as good as water to collect the enclosed spirits, but not to irritate them. Also the experiment must be made more widely both on ashes and calcined products of different bodies, and by use of different liquids.

Negative to the Nineteenth.

xxv. To this Instance is subjoined the *Negative* of other Metals, which are softer and more soluble. For Gold-leaf, if dissolved into a liquid by means of *Aqua Regis*, gives out no Heat to the touch in the process of solution; nor in like manner does Lead dissolved in *Aqua Fortis*. Nor, too, does Quicksilver (as far as I remember), but Silver itself causes very little Heat, and Copper, too, (as far as I remember,) but more evidently Tin, and most of all Iron and Steel; which cause not only great Heat in solution, but violent ebullition as well. And so Heat seems to be produced by conflict, when strong waters penetrate, eat into, rend asunder the parts of bodies, and bodies themselves resist. But where bodies more readily yield, there Heat is scarcely excited.

To the Twentieth.

xxvi. To Heat of Animals no *Negative* is subjoined, unless it be the case of Insects (as has been remarked) in consequence of the smallness of their bodies. Moreover in Fishes as compared with Beasts, it is rather a lower degree of Heat that is noted than absence of it. In Vegetables, also, and Plants no degree of Heat is perceptible to the touch, neither in their exudations, nor in their pith when newly laid bare. Also in Animals a great difference of Heat is found to exist: both in their parts (for the Heat is different at the heart, the brain, or the outward parts) and in their accidents, as in vehement exercise, and fevers.

To the Twenty-first.

xxvii. To this instance a *Negative* can scarcely be applied. It may be added, that Animal Ordure, even when not fresh, evidently has potential Heat, as is observed it its enriching the soil.

To the Twenty-second and Twenty-third.

xxviii. Liquids (whether they be called "Waters" or "Oils") which have great and intense acridity, produce the effects of Heat in rending bodies asunder, and after a while in burning them—but yet to the touch of the hand they are not hot at first. They work, however, according to affinity and the pores of the body to which they are applied. For *Aqua Regis* dissolves Gold, but Silver not at all: on the other hand, *Aqua Fortis* dissolves Silver, but Gold not at all: neither of them dissolves Glass. And so of the rest.

To the Twenty-fourth.

xxix. Let an experiment be made with Spirits of Wine on Wood, also on Butter, Wax, Pitch; to see if perhaps by its own Heat it liquifies them at all. Farthermore, the 24th Instance shews its power of imitating Heat, by its Incrustations. And so let experiment in like manner be made in liquefactions. Let experiment be also made by means of a graduated Glass or Thermometer, concave outwards at the top, by pouring into that outer cavity Spirits of Wine well rectified, with a covering, so that it may the better retain its Heat; and let note be taken as to whether it makes the water descend by its own Heat.

To the Twenty-fifth.

xxx. Spices, and Herbs sharp to the Taste, especially if taken internally, are perceived to be hot. And so we must see in what other materials they produce the effects of Heat. And sailors tell us, that when heaps and masses of Spices which have been long shut up are opened suddenly, there is some danger to those who first stir and take them out of fevers and inflammations. Similarly, experiment can be made, as to whether powders of Spices and Herbs of this kind do not dry Bacon, and Meat hung over them, just as smoke does.

To the Twenty-sixth.

xxxi. There is an acrid power or penetration in cold substances, like Vinegar, and Oil of Vitriol, as much as in hot ones, like Oil of Marjoram and the like. And so they equally cause pain to Animate bodies, and separation and consumption in Inanimate. And to this Instance no *Negative* is discovered. Also, in Animate bodies no pain is found except accompanied with some sense of Heat.

To the Twenty-seventh.

xxxii. Many actions of Cold and Heat are common, though in a very different way. For even snow seems after a while to burn boys' hands; and Cold preserves flesh from putrefaction, no less than fire; and Heat contracts bodies, as does also Cold. But these and the like are better referred to the inquiry into Cold.

13. Thirdly, we must make a *Presentation to the Intellect* of Instances in which the Nature we are investigating exists in greater or less degree; either by comparing increase and decrease in the same subject, or its degree in different subjects in turns. For since the Form of a thing is that thing's very essence; and since a thing differs from its Form no otherwise than as the apparent differs from the essential, or the external from the internal, or what is referred to man from what is referred to the Universe: it surely follows, that no Nature is to be received as true Form, unless it perpetually decreases, as that Nature itself decreases; and likewise perpetually increases, as that Nature itself increases. And this Table we are wont to call *a Table of Degrees*, or *of Comparatives.*

A Table of Degrees, or *Comparatives in Heat.*

And first, we will speak of those things which have no degree of Heat at all to the touch; but seem to have only some potential Heat, or disposition towards and preparation for Heat. Afterwards we shall descend to those things which are actually, or to the touch, hot, and to their strength and degrees.

i. Among solid and tangible bodies there is none found which in its own Nature is originally hot. For no stone, metal, sulphur, fossil, no wood, nor water, nor corpse of any animal, is found to be hot. Hot waters in baths seem to be heated by accident, or by flame or subterraneous fire, such as belches forth from Etna and many other mountains; or by conflict of bodies, as Heat arises in solution of Iron and Tin. And so there are no degrees of Heat in things inanimate, as far as man's touch discerns; and yet these differ in degree of Cold; for wood and metal are not equally cold. But this belongs to a Table of Degrees in Cold.

ii. But as regards potential Heat and preparations for flame, very many inanimate substances are found much disposed towards it, as Sulphur, Naphtha, Saltpetre.

iii. Things which before were hot, like horse-dung in animal substances, or lime, or perchance ashes, or soot of fire, retain some latent remnants of their former Heat. And so there arise certain distillations and separations of bodies, through burial in horse-dung; and Heat is caused in lime by scattering water on it; as was just now said.

iv. Among vegetables there is no plant or part of a plant (like exsudations or pith) which is found to be hot to man's touch. Yet (as has been said above), green herbs when confined grow hot; and to the inner sense of touch, as to the Palate or the Stomach, or even to the outward parts after some delay (as in plasters and ointments) some vegetables are found to be hot and others cold.

v. In the parts of Animals after death or separation, there is not found to be any Heat to man's touch. For horse-dung itself does not retain Heat unless it be confined and buried. And yet all dung seems to have potential Heat, as is shewn by its fertilising fields. And likewise corpses of Animals have latent and potential Heat of this kind; so that in Cemeteries, where burials take place daily, the earth collects a kind of occult Heat, which consumes any corpse newly laid there far more rapidly than pure earth would. And it is said that among the Orientals some fine soft woven cloth has been discovered, made of birds' plumage, which by its innate power dissolves and liquefies butter, if it be lightly wrapped up in it.

vi. Fertilising substances, as dung of all kinds, chalk, seashore sand, salt, and the like, have some similar disposition towards Heat.

vii. All putrefaction has in itself some rudiments of slight Heat, though not so far as to be perceptible to the touch. For not even those substances which by putrefaction are turned into animaculæ, as flesh, or cheese, are perceptibly hot to the touch; nor rotten wood, which shines by night. But the Heat of putrid substances sometimes shews itself by rank strong smells.

viii. And so the first degree of Heat among those things which are perceived to be hot to the touch, seems to be the Heat of Animals, which has a considerable extent of degrees: for the lowest degree (as in insects) is scarcely perceptible to the touch; while the highest degree scarcely equals the degree of Heat of the Sun's Rays in the hottest regions and seasons; nor is it so great as to be unbearable by the hand. And yet they tell us of Constantius, and some others, who were of so dry a constitution and habit of body, that when attacked by very acute fevers they grew so hot as almost to seem to burn the hand which touched them.

ix. Animals increase in Heat by motion and exercise, wine and feasting, love, burning fevers, and pain.

x. Animals in attacks of intermittent fevers are taken with cold and shivering at first; but after a little grow much hotter: this also takes place from the beginning in burning and pestilential fevers.

xi. Let farther inquiry be made as to the comparative Heat in different Animals, as Fish, Quadrupeds, Serpents, Birds; and in their Species also; as in the Lion, the Kite, or Man; for according to popular opinion, Fishes are less hot internally, Birds most hot; especially Doves, Hawks, Ostriches.

xii. Let farther inquiry be made concerning the comparative Heat in the same Animal in its parts and different members. For Milk, Blood, Seed, Eggs, are found to be warm in a moderate degree, and less hot than external flesh in the Animal in motion or agitated. But similarly no inquiry has as yet been made into the degrees of Heat in the Brain, Stomach, Heart, and other parts.

xiii. All animals in winter and cold weather grow cold outwardly; but inwardly they are thought to become more hot than usual.

xiv. The Heat of the Heavenly Bodies even in the hottest region, and hottest periods of the year and day, does not reach such a degree of Heat as to kindle and burn up either very dry wood, straw, or even tinder, unless it be increased by means of Burning Glasses; but yet it can draw out vapour from moist substances.

xv. According to the teaching of Astronomers, some Stars are laid down to be more, some less hot. For among the Planets, Mars is put next in Heat to the Sun: then Jupiter; then Venus; the Moon is regarded as cold, and coldest of all Saturn. Moreover, among fixed Stars, Sirius is set down as hottest; then Cor Leonis or Regulus: then Canicula; &c.

xvi. The Sun causes greater Heat, the nearer it approaches a perpendicular position or the Zenith; and this too is to be believed of the other Planets in their degree of Heat: e. g. Jupiter gives out greater Heat, when he is in Cancer or Leo, than when in Capricorn or Aquarius.

xvii. One must believe that the Sun itself, and the other Planets cause greater Heat in their Perigees, in consequence of their nearness to the Earth, than in their Apogees. And if it should so happen, that in any region the Sun is at the same time in Perigee, and nearer to the Perpendicular; it is necessary it should cause more Heat than in a region in which the Sun is also in Perigee, but more oblique. So that a comparison of the height of Planets ought to be marked down, as they are more perpendicular or oblique, according to the difference of regions.

xviii. The Sun, too, and the other Planets likewise are thought to cause greater Heat, when nearest the larger fixed Stars; as when the Sun is in Leo, he is nearer Cor Leonis, Cauda Leonis, Spica Virginis, Sirius, and Canicula, than when he is in Cancer, where however he is more perpendicular. And one must believe that the different parts of the sky pour down more Heat (though any thing but perceptible to the touch) according as they are more adorned with Stars, especially if they be large ones.

xix. On the whole, the Heat of Heavenly Bodies is increased in three ways; viz. (1) as they become perpendicular: (2) by nearness or Perigee; (3) by conjunction or consort of Stars.

xx. There is found to be a very great interval between the Heat of Animals, and even of the Rays of Heavenly bodies (as they are transmitted to us), and the very gentlest Flame, and all ignited substances, and, still more, liquids, or air itself heated exceedingly by fire. For even the flame of Spirits of Wine, especially if rare and not close gathered, is yet able to light straw, linen, or paper; a thing which the Heat of animals or of the Sun will never do without Burning Glasses.

xxi. Of Flame and ignited substances there are very many degrees in strength and weakness of Heat. But in this there has no diligent inquiry been made; so that it is necessary for us to pass lightly over it. Of all flames that of Spirits of Wine seems to be softest; unless perhaps the Ignis fatuus, or the flames or flashes of animal perspiration, be softer. We think the flame of light and porous vegetables, as straw, reeds, dry leaves, follows next; from which the flame of hair or feathers differs but little. Then perhaps follows flame of wood, especially of those kinds which have no great amount of rosin or pitch in them; that of small wood, such as is commonly gathered into fagots, is gentler than that of trunks of trees and roots. And this may be commonly tried in furnaces for melting Iron, in which the fire of fagots and boughs is not very useful. After this follow (as we think) the flames of oil, tallow, wax, and the like oily and fat substances, which have no great sharpness. But the most powerful Heat is found in Pitch and Rosin, and still more in Sulphur, Camphor, Naphtha, Saltpetre, Salts (after their crude matter has been discharged), and in their compounds, as in Gunpowder, Greek Fire (which men commonly call wildfire), and its different kinds, which have so obstinate a Heat, that they are not easily extinguished by water.

xxii. We think, too, that the flame which results from some imperfect Metals is very strong and violent; but on all these points let further inquiry be made.

xxiii. The flame of forked Lightning seems to exceed all these flames; so that sometimes it has melted wrought Iron into drops; a thing which those other kinds of flame cannot do.

xxiv. Also, in ignited substances there are different degrees of Heat, into which no diligent inquiry has been made. We think that the Heat of tinder, which we are wont to use to obtain fire, likewise that of touch-wood or dry rope, which are applied to discharge cannon, are the weakest. Next follow ignited charcoal, cinders, even burning bricks, and the like. But the most vehement Heat among ignited substances we consider to be that of ignited Metals, as Iron, Copper, &c. But into these also farther inquiry is to be made.

xxv. Some ignited substances are found to be far hotter than some kinds of flame. For ignited Iron is far hotter and more burning than the flame of Spirits of Wine.

xxvi. Even of those things which are not ignited, but only heated by fire, like hot water, and air confined in Reverberatories, some are found to exceed in Heat many kinds of flame and ignited substances.

xxvii. Motion increases Heat; as one can see in bellows and the blowpipe; so that the harder metals are not dissolved or melted by means of still quiet fire, unless it be quickened by the blowpipe.

xxviii. Let experiment be made by means of Burning Glasses, in which (as far as I remember) this follows, that if the Glass be put (say) a span distant from the combustible object, it does not kindle or burn so much as if it be placed (say) at half a span, and is then gradually and slowly drawn to a span's distance. Yet the cone and focus of rays are the same, but it is the motion that increases the operation of the Heat.

xxix. We think that those conflagrations which take place when a high wind is blowing make more progress against than with the wind; because flame leaps back with a swifter motion when the wind lulls, than it advances when the wind drives.

xxx. Flame does not burst forth or arise, unless there be some hollow space for it to move and play in; except in the exploding flame of Gunpowder, and the like, where compression and imprisonment of the flame increases its fury.

xxxi. The Anvil under the Hammer becomes very hot: so much so that if the Anvil were of a somewhat thin plate, we think that by strong and continual blows of the Hammer it might grow redhot, like ignited Iron: but let the experiment be made.

xxxii. But in ignited porous substances, where space is allowed for exercise of the motion of fire, if that motion be restrained by violent compression, the fire is immediately extinguished; as when Tinder, or the burning wick of a candle or lamp, or even burning charcoal or coal, are squeezed by the snuffers, or stamped on by the foot, or the like, the operations of fire immediately cease.

xxxiii. Approximation to a hot body increases Heat, according to the degree of approximation; as is also the case with light: for the nearer an object is placed to the light the more visible it is.

xxxiv. Union of different Heats augments Heat, unless an actual combination of bodies takes place. For a great fire and a little fire in the same place augment somewhat one another's Heat; whereas warm water poured into boiling cools it.

xxxv. Continued presence of a hot body augments Heat. For the Heat continually passing through and flowing forth is mixed with the Heat previously existing, and so multiplies Heat. For a fire does not heat a room so much in half an hour, as if it remained there for a whole hour. But this does not hold of Light; for a lamp or candle, set in any place, gives no greater light after a long stay than at the very first.

xxxvi. The irritation caused by surrounding Cold augments Heat, as can be seen in fires during sharp frost. This we think results not so much from the confinement and compression of the Heat, (which is a kind of union,) as from its exasperation: just as when Air is violently confined or a stick bent, it does not leap back to exactly where it was before, but even farther. And so let diligent experiment be made, by means of a stick or any thing of the kind thrust into the flame, whether it is not burnt more quickly at the edges than in the middle of the flame.

xxxvii. Moreover there are many degrees of susceptibility of Heat. And first of all, it must be noticed how small and gentle a Heat changes and somewhat warms even those bodies which least of all are susceptible of it. For the Heat of the hand itself somewhat heats a ball of lead, or of any metal, if held a little while. So easily, and in all substances, is Heat transmitted and roused, the body to all appearance being nohow changed.

xxxviii. Of all bodies we know Air is the most ready to receive and lose Heat: and this is best seen in Heat-Glasses (Thermometers). Their construction is as follows: Take a glass with a hollow belly, and thin long neck; turn it upside down, and put it, mouth down, belly up, into another glass containing water, so that the mouth of the first vessel touches the bottom of the other; then let the neck of the first lean gently on the mouth of the second, so that it may be at rest; for greater ease in doing this, let a little wax be put on the mouth of the second vessel, not though so that its mouth is quite closed up, lest, by preventing the transit of Air, the motion, of which we are now going to speak, and which is very gentle and delicate, be hindered.

The first glass ought, before being placed in the second, to have its upper part (its belly) heated. After it is placed, the air (which had been expanded by the heating) will draw in and contract (after a sufficient time to allow for the extinction of the adventitious Heat) to the same extension or dimension as that of the ordinary outer Air at the moment of its insertion; and will draw the water up to a proportionate height. There ought too to be attached to it a long narrow slip of Paper, marked off with Degrees at pleasure. Then you will see, that as the temperature of the day grows colder or hotter, the air contracts from the Cold, expands from the Heat: and this will be exhibited by the ascent of the water when the air contracts, and its descent or depression, when the air expands. The sensibility of the Air, as to Heat and Cold, is so subtle and exquisite, that it far surpasses the human Touch: so that any ray of Sunlight, or Heat of breath, or, far more, Heat of the hand placed on the top of the Glass, directly and clearly depresses the water. And yet we think that the Spirit of

Animals has a still more exquisite sense of Cold and Heat, only that it is hindered and blunted by the mass of their bodies.

xxxix. After Air, we think those bodies which, like snow and ice, are recently changed and congealed by Cold, are the most sensitive of Heat. For they begin to dissolve and melt under influence of any gentle warmth. After these follows, perhaps, Quicksilver; after it fat substances, oil, butter, &c.; then wood; then water. Lastly stones, and metals which do not readily grow hot, especially internally. But these retain the Heat they have once acquired for the greatest time; so that Brick, Stone, or ignited Iron, plunged or thrown into a basin of cold water, retain their Heat, so as to be too hot to touch, for a quarter of an hour, more or less.

xl. The less the mass of a body, the quicker it grows hot by approximation of a hot body. This shews that all Heat we know of is somehow averse to a tangible body.

xli. Heat, as far as regards human sense and touch, is a shifting and relative thing; so that warm water, if one's hand be cold, is felt to be hot; if one's hand be hot, is felt to be cold.

14. Any one may readily see how deficient we are in History, when in the above Tables, besides that in the room of approved History, and sure Instances, we have sometimes inserted tales and reports, (always, however, with the addition of a mark of doubtful credit and authority,) we are very often obliged to make use of such phrases as "Let experiment be tried," or "Let farther inquiry be made."

15. We are wont to call the work and duty of these Three Tables, *Presentation of Instances to the*

Intellect. After *Presentation* made, *Induction* itself is to be set to work. For there must be found, on *Presentation* of each and all Instances, such a Nature as may be always present or absent when the given Nature is so; which may increase and decrease with it; and which may be (as has been said above) a limitation of a more common Nature. Now if the mind tries to do this affirmatively from the beginning; (and when left to itself it is ever wont to do so;) there will rise up Phantoms, Matters of Opinion, Conceptions ill defined, Axioms needing daily emendation; unless one is allowed (as in the schools) to fight for what is false. And these will doubtless be better or worse according to the powers and strength of the Intellect which produces them. But it only belongs to God, the Bestower and Maker of Forms, or perhaps to Angels and Intelligences, to know Forms immediately and affirmatively, and from the beginning of contemplation. But certainly it is above man; to whom it is permitted only to proceed first by *Negatives*, and lastly to end with *Affirmatives* after every kind of exclusion.

No !

16. And so there must be made an entire solution and separation of Nature; not by fire, indeed, but by the mind, as by a Divine Fire. And so the first duty of true *Induction* (with a view to discovery of Forms) is the *rejection* or *exclusion* of single Natures, which are not found in any Instance in which the given Nature is present; or which are found in any Instance from which the given Nature is absent; or are found to increase in any Instance, while the

given Nature decreases; or to decrease, while the given Nature increases. Then after *Rejection* and *Exclusion* made in the proper ways, there will remain (as a Residuum)—volatile opinions having passed off like smoke — Form, affirmative, solid, true, and well limited. And this is a short matter to tell; though one arrives at it after many windings. But we will try to omit none of those means which help towards the end.

17. Moreover we must caution people, and warn them continually against taking what we say, when we attach so much importance to Forms, to refer to those Forms to which men's contemplations and thoughts have hitherto been accustomed.

(1) For first we do not speak at present of *Copulate Forms*, which are (as we have said) the conjunction of simple Natures out of the common course of things, as those of a Lion, an Eagle, a Rose, Gold, and the like. For it will be time to treat of these when we have arrived at the *Latent Processes*, and *Latent Structures*, and the discovery of them, as they are found in concrete substances (as they are called) or Natures.

(2) Nor, again, should what we say be understood (even as regards simple Natures) to mean Abstract Forms and Ideas, whether not limited in matter, or badly limited.

(3) For when we speak of Forms, we mean nothing more than those Laws and Limitations of pure action which order and appoint any simple Nature; as Heat, Light, Weight, in every kind of susceptible matter

and subject. And so the Form of Heat or of Light is the same thing as the Law of Heat or of Light: nor, indeed, do we ever withdraw or retreat from things themselves and the practical side of knowledge. Wherefore, for example, when we say, in investigating the Form of Heat, "Reject Rarity," or, "Rarity is no part of the Form of Heat;" it is the same thing as if we said, "Man can superinduce Heat upon a dense body;" or, on the other hand, "Man can take away or ward off Heat from a rare body."

But even if our Forms seem to any one to have something abstract about them, in that they combine and conjoin things heterogeneous (for the Heat of Heavenly Bodies and of Fire seem very heterogeneous; the fixed redness of a Rose, or the like, and the apparent redness in a Rainbow, or in the rays of Opal, or Diamond; or Death from Drowning, Hanging, the Sword, Apoplexy, or Atrophy; and yet these agree in having the Nature of Heat, Redness, Death), let that man know that his is an Intellect caught and held back by habit, by the general condition of things, and by mere opinions. For it is most certain that these things, however heterogeneous and alien from one another, agree in having that Form or Law which orders Heat, Redness, or Death. Nor can man's power be emancipated and freed from the common course of Nature, and be expanded and exalted to new efficients, and new modes of operation, except by revelation and discovery of Forms of this kind. And then, after this union of Nature, which is the chief point of all, mention shall be made in the proper place both of the ordinary, and, still more, of the interior and truer divisions and veins of Nature.

18. Now however must be set forth an Example of *Exclusion* or *Rejection* of Natures, which by the *Tables of Presentation* are found not to be of the Form of Heat.

Meanwhile we must warn people, that not only is each Table sufficient for the *Rejection* of any Nature, but even any one of the single Instances contained in them. For it is manifest from what has been said, that every *contradictory Instance* destroys that hypothesis as to Form (which it contradicts). But nevertheless we sometimes, for clearness, and to shew more plainly the use of Tables, double or repeat the *Exclusion*.

An Example of an Exclusive Table, or Rejection of Natures from the Form of Heat.

i. By the Sun's Rays, *reject* Elementary Nature.

ii. By common Fire, and especially by subterraneous Fires (which are most remote, and are most shut off from the rays of the Heavenly Bodies) *reject* Heavenly Nature.

iii. By heating of every kind of Body (i. e. Minerals, Vegetables, exterior parts of Animals, Water, Oil, Air, and the rest), by approximation only to fire or other hot body; *reject* all variety or more subtle texture of bodies.

iv. By Iron and ignited Metals, which heat other bodies, and yet are not at all lessened in weight or substance; *reject* the imparting or mixture of the substance of another hot body.

v. By boiling Water and Air, and even by Metals and other solid bodies when heated, but not so as to ignite or become redhot; *reject* light and the being luminous.

vi. By the Rays of the Moon, and of other Stars (except the Sun), *reject* light and the being luminous.

vii. By the *comparative* of ignited Iron, and of the flame of Spirits of Wine (whereof ignited Iron has more Heat and less Light; flame of Spirits of Wine more Light and less Heat), *reject* also light and the being luminous.

viii. By Gold and other Metals when ignited, which are most dense of body in their whole (*secundum totum*), *reject* rarity.

ix. By Air, which for the most part is found to be cold, and yet remains rare, *reject* also rarity.

x. By ignited Iron, which does not expand in mass, but remains within the same visible dimensions; *reject* local or expansive motion in the whole (*secundum totum*).

xi. By expansion of Air in Heat-Glasses (Thermometers) and the like, where it is moved locally, and clearly expands, and yet gains no manifest increase of Heat; *reject* also local or expansive motion in the whole (*secundum totum*).

xii. By the ready warming of all bodies, without any notable destruction or alteration; *reject* destructive Nature, or the violent communication of any new Nature.

xiii. By consent and conformity of similar effects, produced by Heat and Cold; *reject* both expansive and contracting motion in the whole (*secundum totum*).

xiv. By the kindling of Heat from rubbing bodies together; *reject* Principal Nature, by which we mean that which is found existing positively in Nature, and is not caused by any preceding Nature.

There are, too, other Natures: for we do not make perfect Tables, but only Examples.

Each and all of the above Natures are not of the

Form of Heat. And man, operating upon Heat, is freed from all of them.

19. In the *Exclusive Table* are laid the foundations of true *Induction*, which, however, is not completed till we rest in the Affirmative. Nor is the *Exclusive Table* itself at all complete, nor can it be so at first. For the *Exclusive Table* is clearly a *Rejection* of simple Natures. But if we have not as yet good and true conceptions of simple Natures, how can the *Exclusive Table* be rectified? Some of the above (as the conceptions of Elementary Nature, of Heavenly Nature, of Rarity) are vague and ill defined. And so we, who are neither ignorant nor forgetful of the magnitude of the work we are attempting (viz. the rendering man's Intellect equal to things and Nature) do not in the least rest in what we have already taught; but carry on the matter farther, and contrive and administer stronger aids for the use of the Intellect. These we will next subjoin. And certainly in the *Interpretation of Nature* the mind is to be so entirely prepared and formed, that it may both support itself in the proper steps of certainty, and also think (especially at first) that what it has depends much on what yet remains to be reached.

20. Moreover, since Truth emerges more quickly from error than from confusion, we think it useful to grant permission to the Intellect, after having composed and weighed three such *Tables of First Presentation* as we have made, to gird itself up and attempt the *Interpretation of Nature* in the Affirmative, both from the Instances in the Tables, and

from those which occur elsewhere. And this kind of attempt we are wont to call *The Permission of the Intellect*, or *The Commencement of Interpretation*, or *The First Vintage*.

First Vintage of the Form of Heat.

It must be observed that the Form of a thing (as is clear from what has been said) subsists in each and all the Instances in which the thing itself subsists; for otherwise it would not be Form: and so clearly no contradictory Instance can be alleged. And yet the Form is found to be far more conspicuous and evident in some Instances than in others; in those, that is, in which the Nature of the Form is less restrained and hindered and reduced to order by other Natures. Now we are wont to call Instances of this sort *Glaring* or *Ostensive Instances*. But now we must proceed to this the *First Vintage of the Form of Heat*.

From the *Instances*, each and all, it appears that the Nature of which Heat is a Limitation, is Motion. This is most clearly shewn in Flame, which moves perpetually; and in hot or boiling liquids, which also move perpetually. And it is also shewn in the rousing or increasing of Heat by means of Motion; as by bellows and winds: for which see Table iii. Inst. 29. Similarly in other manners of motion; for which see Table iii. Instt. 28, 31. Again it is shewn in the extinction of Fire and Heat by all strong compression, which bridles and stops Motion: see Table iii. Instt. 30, 32. It is also shewn in this, that every body is destroyed, or, at least strikingly changed by all strong and vehement Fire and Heat. Whence it is quite clear that through Heat tumult, perturbation, and violent motion arise in the inner parts of the body, which gradually tends towards dissolution.

Let what we have said about Motion (viz. that it is like a Genus to Heat) be understood not to mean that Heat generates Motion, or Motion Heat, (though this too may be true in some cases); but that essential Heat, or the "*quid ipsum*" of Heat, is Motion, and nothing else; limited however by *Differences*, which we will presently subjoin, after we have added some cautions for the avoiding of ambiguity.

Sensible Heat is a relative thing; and refers to man, not to the Universe: and is laid down rightly to be only the effect of Heat upon Animal Spirit. Farthermore, it is in itself a variable thing, as the same body (as Sense is predisposed) produces a perception either of Heat or of Cold; as is clear from Table iii. Inst. 41.

Nor indeed ought the communication of Heat, or its transitive Nature, by which a body applied to a hot body grows hot, to be confounded with the Form Heat. For Heat is one thing, and Heating another. For Heat is induced by Motion of attrition without any preceding Heat: whence Heating is excluded from the Form of Heat. And even where Heat is produced by approximation of a hot body, this is not caused by the Form of Heat; but it entirely depends on a higher and more common Nature; viz. on a

Nature of Assimilation or Self-Multiplication: on which separate inquiry must be made.

Farther; the conception of Fire is vulgar and of no worth: for it is compounded of the concourse of Heat and Light in any body; as in common flame and redhot bodies.

And so every ambiguity having been removed, now at length we must come to the true *Differences* which limit Motion, and fashion it into the Form of Heat.

i. Now the *First Difference* is this; that Heat is *expansive* Motion, by which a body strives to dilate itself, and to occupy a larger sphere or space than it did before. Now this *Difference* is most shewn in flame, where the smoke, or thick vapour, is manifestly dilated and bursts into flame.

It is shewn also in all boiling liquids, which clearly swell, rise, emit bubbles, and urge on the process of self-expansion, until they are turned into a far more extended and dilated body than the liquid itself; viz. into vapour, smoke, or air.

It is also shewn in every kind of wood and combustible; for in these exudation sometimes occurs, evaporation always.

It is shewn too in the melting of Metals; which, as they are of most compact body, do not readily swell and dilate: but still their spirit, after it is itself dilated and desires a still greater dilatation, forces and drives the more solid parts into a liquid. And if Heat be still more strongly applied, it dissolves and turns much of them into vapour.

It is shewn also in Iron or Stones: for these though not liquefied or melted, are yet softened. The same thing happens to sticks, which become flexible if heated a little while in hot cinders.

This Motion is, however, best observed in Air, which forthwith and plainly expands under a small degree of Heat, as is seen Table iii. Inst. 38.

It is also shewn in the contrary Nature of Cold. For Cold contracts every body and forces it into a narrower space: so that through intense Cold nails fall out of walls; brass cracks; heated glass suddenly exposed to Cold cracks and breaks. Similarly Air contracts under influence of slight cooling: as is seen Table iii. Inst. 38. But on this shall more be said in inquiry into Cold.

Nor is it wonderful if Heat and Cold produce many common actions (as to this see Table ii. Inst. 32.) when two of the following *Differences*, soon to be spoken of, are found to belong to either Nature; although in this *Difference* of which we are now speaking their actions are diametrically opposite; for Heat gives expansive and dilating Motion, Cold a contracting and condensing Motion.

ii. The *Second Difference* is a modification of the foregoing; viz. that Heat is expansive Motion (or towards the exterior), but under this law, that the body is borne upwards with it. For without doubt there are very many kinds of mixed Motion. For example: an arrow or javelin acquires a rotatory motion by progression, and a progressive one by rotation. Similarly the Motion of Heat is both expansive and tends upwards.

But this *Difference* is shewn by putting tongs or poker into the fire. For if put in perpendicularly, with the hand above, they quickly burn the hand; if sideways or from below, much more slowly.

It is also conspicuous in distillation "per descensorium," which men make use of for the more delicate flowers whose odour readily escapes. For industry has discovered the plan of placing the fire over instead of under them, so that it should burn less. For not only does flame, but every kind of Heat tend upwards.

Let an experiment on this be made in the contrary Nature of Cold: viz. whether Cold does not contract the body downwards; just as Heat expands it upwards. And so take two similar Iron rods, or tubes of Glass: heat them a little; place a sponge full of cold water, or some snow, over the one and under the other. For we think that the refrigeration will be more rapid at the extremities of that rod over which the snow is placed, than of that one under which it is placed: the contrary to the action of Heat.

iii. *The Third Difference* is this. Heat is Motion, not expansive uniformly in the whole, but expansive through the lesser particles of the body; and at the same time restrained, repelled, and reflected; so that it obtains an alternative Motion, ever hurrying, striving, struggling, and irritated by repercussion; whence the fury of fire and Heat has its origin.

This *Difference* is shewn most in flame and boiling liquids: for these are in perpetual excitement, swell in small portions, and subside again.

It is also shewn in those bodies, which are so tightly knit together, that when heated or ignited they do not swell or dilate in bulk; as in the case of ignited Iron, in which Heat is most violent.

It is also shewn in the fact that during the coldest weather the fire burns most brightly.

It is also shewn in this; that when air is expanded in the Thermometer without impediment or repulsion, (i. e. uniformly and equally,) Heat is not perceived. Also in confined winds, though they burst forth with the greatest violence, yet no remarkable Heat is perceived; because in that case Motion takes place in the whole, and without alternating Motion in particles. And let experiment also be tried as to whether flame does not burn more briskly at the sides than in the middle of the flame.

It is also shewn in the fact that any kind of burning proceeds through minute pores of the body burnt; so that burning undermines, penetrates, pierces, pricks, just as if it were an infinite number of needle-points. And so it comes, that all strong waters (if taken in due proportion to the body on which they act) exhibit the effects of Fire, through their corrosive and pungent Nature.

And this *Difference*, of which we are now speaking, is common with the Nature of Cold; in which the contracting Motion is restrained by the resistance of expansion; just as in Heat the expansive Motion is confined by the resistance of contraction.

And so whether parts of a body penetrate towards the interior or the exterior, the reason is the same; though the force in the two cases is very different, arising from the fact that we have nothing here upon the surface of the earth that is intensely cold. See Table i. Inst. 27.

iv. The *Fourth Difference* is a modification of the foregoing one: viz. this Motion of stimulation or penetration ought to be somewhat rapid, and not at all sluggish; and to take place through particles, which, though minute, are still not of extreme subtilty, but of rather larger dimensions.

This *Difference* is shewn in comparing the effects of Fire with the effects of Time or Age. For Age or Time dry up, consume, subvert, reduce to ashes, as well as Fire; nay far more subtly; but because Motion in their case is very sluggish, and in particles of great minuteness, Heat is not perceived.

It is also shewn in comparison between the dissolving of Iron and Gold. For Gold is dissolved without excitement of Heat; but Iron with vehement excitement; though they take about the same time. This is because in Gold the entrance of the acid of separation is gentle and subtly insinuating, and the particles of Gold yield easily: whereas in Iron the entrance is rough and with conflict, and the parts of Iron are more obstinate.

It is also shewn (up to a certain point) in some gangrenes and mortifications of flesh; which, from the subtilty of the putrefaction, do not excite great Heat or pain.

And let this be the *First Vintage*, or *Commencement of Interpretation* of the Form of Heat, made by the *Permission of the Intellect.*

Now from this *First Vintage* the Form or true Definition of Heat (i. e. of Heat relative to the Universe, not merely to man's senses) is briefly this. *Heat is Motion, expansive, restrained, and struggling through the lesser parts* (*of a body*). Expansion is modified: *though expanding in every direction, yet it somewhat tends upwards.* And that struggling through the parts is also modified: *it may not be at all sluggish, but vigorous and of some impetuosity.*

But as regards the practical side, the thing is the same. For this is the account of it. *If in any natural body you can excite the Motion of self-dilatation or expansion; and also can so repress that Motion, and turn it upon itself, that that dilatation proceed unequally, partly taking place, partly being repressed, without doubt you will generate Heat:* and this without considering whether that body is elementary, (as they term it,) or imbued with celestial influence; whether luminous or opaque; rare or dense; locally expanded, or contained within bounds of its first dimensions; verging towards dissolution, or remaining in its condition; animal, vegetable, or mineral; water, oil, or air; or any other substance whatsoever that is susceptible of the aforesaid Motion. Sensible Heat, also, is the same thing; but under such relation as agrees with the Senses.

But now we must proceed to farther helps.

21. After the *Tables of First Presentation*, and *Rejection* or *Exclusion*, and also of the *First Vintage* made according to them; we must proceed to the remaining helps of the Intellect for *Interpretation of Nature* and true and perfect *Induction*. And in setting forth these we will proceed, where Tables are required, with Heat and Cold; but where there are only few examples required, we will proceed with all other subjects; so that inquiry be not confounded, and yet our teaching be within less narrow limits.

We will speak, then, (1) of *Prerogative Instances;* (2) of *the Supports of Induction;* (3) of *the Rectification of Induction;* (4) of *the Variation of Inquiry according to the Nature of the Subject;* (5) of *Prerogative Natures*, with a view to investigation; or of what is to be investigated first and what afterwards; (6) of *the Limits of Investigation*, or *the Synopsis of all Natures* in the Universe; (7) of *Deduction to Practice*, or of what is arranged relatively to man; (8) of *the Preparations for Investigation;* (9) of *the Ascending and Descending Ladder of Axioms.*

22. First among *Prerogative Instances* we will set forth *Solitary Instances.* Those are *Solitary* which (1) exhibit the Nature under Investigation, in those subjects which have nothing in common with other subjects except that Nature itself: or again, (2) those which do not exhibit the Nature under Investiga-

tion, in those subjects which are like in all points to other subjects, except in that Nature itself. For it is clear that instances of this kind remove doubt, and accelerate and strengthen the *Exclusive* part: so that a few of them are a host.

(1) For example: In Investigation into the Nature of *Colour; Solitary Instances* are Prisms, crystalline Gems, which produce Colours, not only in themselves, but when externally cast upon a wall, Dew, &c. For these have nothing in common with fixed Colours in Flowers, coloured Gems, Metals, Wood, &c. except Colour itself. Hence it is readily gathered that Colour is nothing but a modification of the image of Light incident and refracted; in the former kind by different degrees of Incidence; in the latter, by various textures and structures of body. And these are *Solitary Instances* of resemblance.

(2) Again, in the same Investigation, distinct veins of white and black in Marble, and variegations of Colour in flowers of the same species, are *Solitary Instances*. For white and black Marble, and white and purple spots in the Gillyflower, agree in almost every point except in Colour itself. Hence it is readily gathered that Colour has not much to do with the intrinsic Natures of any body, but only depends on the gross and as it were mechanical position of parts. And these *Instances* are *Solitary* in discrepant subjects. Both kinds we are wont to call *Solitary Instances*, or *Ferinæ*, to take a Term from Astronomers.

23. Second among Prerogative Instances we will place *Migrating Instances.* These are those in which the Nature under Investigation migrates towards generation, when it did not exist previously: or, on the other hand, migrates towards corruption, when it did exist previously. And so in each division such Instances are always twofold; or rather, one Instance in motion or passage is carried on to an end opposite to what it was before. Instances of this kind not only quicken and strengthen *Exclusion,* but also drive *Affirmation,* or the Form itself, into narrow limits. For it is necessary that the Form of a thing should be something which is conferred by *Migration* of this kind; or else removed and destroyed by it. And although every *Exclusion* promotes *Affirmation,* yet this is more directly the case in the same subject than in different ones. Now Form (as is clear from every thing we have said) by shewing itself in one case leads to all. And the more simple the *Migration,* the more valuable the Instance. Besides, *Migrating Instances* are of great use for the practical side; for when they set forth the Form joined with that which causes or takes it away, they clearly point out practice in some cases; from which the transition to the cases nearest to them is easy. There is, however, some danger in these Instances, which requires caution; viz. the danger of reducing Form too much to an Efficient, and of filling, or at least tinging the Intellect with a false opinion about Form, from regarding the Efficient, which is always

laid down to be nothing more than the vehicle or bearer of the Form. But this is easily remedied by means of properly conducted *Exclusion.*

And now we must give an example of a *Migrating Instance.* Let the Nature sought be *Whiteness.* A *Migrating Instance* towards generation is Glass unbroken, and Glass powdered. Similarly, Water in its natural state, and Water beaten into foam. For Glass unbroken, and Water in its natural state, are transparent, not white; Glass powdered, and Water in foam, are white, and not transparent. And so inquiry must be made as to what has happened to Glass or Water from that *Migration.* For it is clear that the Form of Whiteness is brought in by that contusion of Glass and agitation of Water. For nothing is found to have been added except the diminution of the parts of Glass and Water, and the insertion of Air. Nor is it small progress towards discovery of the form of Whiteness, that two bodies, transparent in themselves, more or less, (i. e. air and water, or air and glass,) if put together in minute portions, should exhibit Whiteness by the unequal refraction of rays of light.

But in this matter we must give also an example of the danger and the caution of which we have spoken. Doubtless it will readily here occur to an Intellect depraved by efficients of this kind, that Air is always required to produce the form of Whiteness: or that Whiteness is generated only by transparent bodies: views which are entirely false, and proved so by many exclusions. But it will rather appear (putting Air and the like aside) that bodies entirely even, in such portions as affect vision, are transparent; but that bodies uneven, and of simple texture, are white; that bodies unequal, and of compound texture, but in order, shew all colours except black; but that bodies unequal, and of compound texture, without order and confused, are black. And so an example has now been given of a *Migrating Instance* towards generation in the required Nature of Whiteness. A *Migrating Instance* towards corruption in the same Nature of Whiteness is dissolving froth or snow: for the water loses its whiteness, and takes its transparency after it becomes whole and without air.

Nor is this anyhow to be passed by, that under *Migrating Instances* ought to be comprehended not only those which migrate towards generation and privation, but those also which migrate towards increase and decrease; as these too help towards the discovery of Form, as is quite plain from the definition of Forms given above, and from our *Table of Degrees.* And so Paper which, while dry, is white, but when wetted (by exclusion of air and admission of water) is less white, and tends more towards transparency, is of the same use with the Instances given above.

24. Third among Prerogative Instances we will place *Ostensive Instances,* which we mentioned in the *First Vintage of Heat,* and which we also call *Glaring* (*elucescentiæ*), or *liberated and predominant Instances.* These are those which shew the Nature

required bare and substantial, and in its exaltation, or the height of its power; i. e. emancipated and liberated from impediments, or at least triumphing over them, suppressing and restraining them by the force of its own virtue. For as every body is susceptible of many copulate Forms of Natures in the concrete; it follows that one drives back, depresses, breaks, and binds another; whence each particular Form is obscured. But there are some subjects found, in which the Nature required is above all others in vigour, either through absence of impediment, or predominance of virtue. And these *Instances* are the most *Ostensive* of Form. But in these also caution is to be observed, and the impetuosity of the Intellect to be restrained. For whatever shews Form, and forces it forward, so that it should seem to meet the Intellect, must be regarded as suspicious, and recourse must be had to severe and diligent *Exclusion.*

For example. Let the nature investigated be Heat. An *Ostensive Instance* of "motion of expansion" (which, as we said above, is the chief part of the Form of Heat) is the Thermometer. For flame, though it manifestly shews expansion, yet, from its momentary extinction, does not shew the progress of expansion. And hot water, from the easy transition of Water into steam and air, does not so well shew the expansion of Water in its own body. Again, ignited Iron, and the like, not only do not shew progress, but on the contrary, through their Spirit being repressed and broken by their compact close parts (which tame and bridle expansion) the expansion is not at all noticeable to the senses. But the Thermometer clearly shews expansion in Air, and that too conspicuous, and progressive, durable, and not transient.

Again, for example; Let the Nature investigated be Weight. An *Ostensive Instance* of Weight is Quicksilver. For it far exceeds all things in Weight, except Gold; which is not much heavier. But Quicksilver is a more signal Instance for indicating the Form of Weight than Gold is; for Gold is solid and consistent, qualities which seem to be referred to Density; while Quicksilver is liquid, and teeming with Spirit, and yet far exceeds in gravity the Diamond and those things which are accounted most solid. Hence it is shewn that the Form of Gravity or Weight dominates simply over the quantity, not over the close consistency of Matter.

25. Fourth among Prerogative Instances we will place *Clandestine Instances*, which we also are wont to call *Instances of the Twilight*. These are, as it were, opposed to *Ostensive Instances*. For they exhibit the required Nature in its lowest vigour, in its cradle, so to speak, and rudimentary; struggling and making a sort of first attempt, but lying hid under a contrary Nature, and subordinate to it. Instances of this class are of very great importance for the discovery of Forms; because as the *Ostensive* lead readily to *Differences*, so the *Clandestine* lead

best to Genera, i. e. to those common Natures of which the Natures inquired into are nothing but limitations.

E. g. Let the Nature required be *Consistency*, or that which limits itself, as opposed to liquid or fluid. *Clandestine Instances* are those which shew some weak and infirm degree of Consistency in a fluid; like water-bubbles, which are a kind of consistent and limited pellicle, made of the substance of Water. Similar instances are dropping liquids, which if there is water to follow, lengthen themselves out into a very thin thread so as not to break the continuity of the water; but if water enough be not forthcoming to follow, it falls in round drops, the figure which best sustains water against separation of its particles; and at the moment of the breaking of the thread of water, when the falling in drops begins, the water itself recoils upwards to avoid breach of continuity. Farthermore, in Metals, which when melted are liquid, but more tenacious, liquefied drops often contract upwards and so remain. There is something of the kind, too, in the Instance of the looking-glasses, which boys are wont to make between rushes with spittle, and in which the Consistency of the pellicle of water is seen. But this is shewn far better in that other child's pastime—when they take water, made a little more tenacious by means of soap, and blow into it through a hollow reed, so as to form of the water a kind of Castle of Bubbles; for it assumes so much Consistency by the introduction of air, that it may be thrown some little distance without bursting. And this is best perceived in frost and snow: for these acquire so much Consistency that they can almost be cut; and yet are bodies formed of air and water, two liquids. And all these instances shew clearly that the conceptions of Liquid and Consistent are only vulgar, and adapted to the senses; and that all bodies really avoid and shun discontinuation; that in homogeneous bodies, like liquids, this is weak and infirm; but in bodies compounded of heterogeneous substances more vigorous and strong: because the introduction of the heterogeneous binds bodies together, while the entrance of the homogeneous looses and relaxes them.

Similarly, for example: let the required Nature be *Attraction* or Coition of bodies. The most remarkable *Ostensive Instance* of its Form is the Magnet. Now the contrary nature to Attraction is non-attraction, though in a like substance: as Iron does not attract Iron, nor Lead Lead, nor Wood Wood, or Water Water. A *Clandestine Instance* is the Magnet armed with Iron, or rather the Iron in an armed Magnet. For its Nature is such that an armed Magnet at some distance does not attract Iron more strongly than one not armed. But if the Iron be put nearer, so as to touch the Iron in the Armed Magnet, then this latter will sustain a far greater weight of Iron than the single unarmed Magnet can; in consequence of the similitude of substance of Iron against Iron. This operation is entirely *Clandestine*, and latent in the Iron before the application of the Magnet. And so it is manifest, that the Form of Coition is something vigorous and strong in a Magnet, weak and latent in Iron. It is likewise observed that little wooden arrows without an Iron point when shot out of great mortars, penetrate more deeply into wood (as into ships' sides, &c.) than the same arrows tipped with Iron, because of the similitude of the substance of wood to wood, although this was previously latent in wood. Likewise, though Air or Water do not manifestly attract Air or Water in the mass, yet one bubble when it approaches another dissolves it more readily than if that other bubble were absent, in consequence of the appetite of coition of Water with Water, Air with Air. And *Clandestine Instances* of this kind (which are of noblest use, as has been said) make themselves most conspicuous in small and subtle portions of bodies: because greater masses of things follow more general and catholic Forms—as shall be said in the proper place.

26. Fifth among Prerogative Instances we will place *Constitutive Instances*, which we are also wont to call *Manipular*. These are those which "constitute" one species of the nature inquired into as a sort of lesser Form. For as legitimate Forms (which are always convertible with Natures inquired into) lie deep, and are hard to be discovered; things and the weakness of man's Intellect demand that particular Forms, which gather together *Handfuls* of certain (not all) Instances into some common conception, should not be

neglected, but diligently noted. For whatever unites Nature, though by imperfect means, paves the way to the discovery of Forms. And so Instances which are useful for this are of no contemptible power, but have some Prerogative.

But in these great care must be used, lest the Intellect of Man, after it has discovered several of these particular Forms, and thence has parted or divided the Nature inquired into, should rest entirely therein, and not gird itself up to the legitimate discovery of the great Form; and take it for granted that Nature is from its very roots multifold and divided, and reject with disgust any farther union of Nature, as a matter of useless subtilty, verging towards empty abstraction.

For example; Let the Nature inquired into be *Memory*, or that which rouses and aids it. *Constitutive Instances* are, (1) Order or Distribution, which clearly assists Memory. Also Common-Places in artificial Memory; and these may be either *Places* in their ordinary sense of the term, as a Door, a Corner, a Window, &c.; or familiar and well-known persons; or any thing else you like (so long as a fixed order be kept) as animals, herbs; even words, letters, symbols, historic personages, &c.; though some of these are more, some less fit and convenient. Places of this kind strikingly aid the Memory, and exalt it far beyond its natural strength. Also verse is recollected and learnt by heart more easily than prose. And from this *Handful* of three Instances; Order, Places of Artificial Memory, and Verse, is constituted one species of help to Memory. And this species may be rightly called "the cutting away of the indefinite." For when any one strives to remember or to recall to mind any thing, if he has no previous conception or perception of what he is seeking, he seeks and labours, and runs to and fro indefinitely: but if he has any previous conception, the indefinite is directly cut off; and the wandering of Memory brought within narrower limits. Now in these three aforesaid instances, the previous conception is perspicuous and certain. In the first there ought to be something agreeing with Order; in the Second an Image bearing some relation or agreement with those determined Places; in the third words which fall into verse. And so the indefinite is cut away.

(2) Other Instances will give a second species; that whatever brings the Intellect to something that strikes the senses (a plan which also flourishes much in Artificial Memory) helps Memory.

(3) Other Instances will give a third species; as those which make an impression by a powerful affection; i. e. those which cause Fear, Wonder, Shame, Delight, help Memory.

(4) Other Instances will give a fourth species; that those things which are most impressed on a pure mind, i. e. one but little occupied before and after; as what is learnt in childhood, or what we fancy before sleep, or the first time of anything happening; these cling most tightly to the Memory.

(5) Other Instances will give a fifth species; that a multitude of circumstances, or Handles, helps

Memory, as writing in paragraphs, reading, or recitation aloud.

(6) Lastly, other Instances will give a sixth species; that what is expected and rouses attention, is better fixed than what flits by. And so if you were to read a writing twenty times through, you would not learn it by heart so readily, as if you were to read it ten times, trying between each reading to say it off, and looking at the book, where Memory fails.

So that there are, as it were, six lesser Forms of those things which help Memory: 1. The cutting away of the Indefinite; 2. The leading the Intellect to the sensible; 3. Impression on a strong affection; 4. Impression on a disengaged mind; 5. A multitude of Handles; 6. Anticipation.

In like manner, for example, let the Nature inquired into be Taste, or the act of Tasting. The following *Instances* are *Constitutive*. He who cannot smell, and is deprived of that sense naturally, does not perceive, or distinguish by Taste rancid or putrid food; nor Garlic, or Roses, or the like. Again, they who have their nostrils accidentally stuffed up by the descent of Rheum, do not discern or perceive anything putrid or rancid, or sprinkled with Rose-water. Again, they who are affected by a cold of this kind, if when they have any thing fœtid or strong-smelling in their mouth, or on their palate, they blow their noses violently, they at that instant have a clear perception of the rancidity or odour. These instances will give and constitute this species, or rather part of Taste; that the sensation of Tasting is nothing but an internal smelling, which passes and descends from the higher passages of the nostrils into the mouth and palate. On the contrary, they whose sense of smell is wanting or stuffed up, perceive, as well as any one else, what is salt, sweet, pungent, acid, rough, bitter, and the like. So that it is clear that the sense of Taste is a compound of internal smell, and of some kind of exquisite Touch, of which we need not here speak.

Likewise, for example; let the Nature inquired into be Communication of quality without mixture of substance. The Instance of Light will give or constitute one species of Communication; Heat and the Magnet, another. For the Communication of Light is momentary, and perishes directly on removal of the original Light. While Heat and Magnetic power, when they have been transmitted, or rather, called out in another body, abide and remain no short time after the first motive power has been taken away.

Finally; the Prerogative of *Constitutive Instances* is very great; for they are those which are of most avail both for Definitions (especially partial ones), and for Divisions or partitions of Natures, as to which Plato said not amiss "that he is to be counted as Godlike, who knows well how to define and divide."

27. Sixth among Prerogative Instances we will place *Conformable or Proportionate Instances*, which we are also wont to term *Parallels*, or *Physical Similitudes*. These are those which shew likenesses and connexions of things, not in the lesser Forms,

as the *Constitutive Instances* do, but simply in the concrete. And so they are like first and last steps towards the union of Nature. Nor do they establish any Axiom immediately from the beginning; but only indicate and observe a certain consent of bodies. And yet though they be not of much avail for the discovery of Forms; nevertheless they reveal with great advantage the fabric of the parts of the Universe, and exercise a sort of Anatomy on its members; and thence sometimes lead us on as by the hand to sublime and noble Axioms; especially to those which relate to the construction of the World, rather than to simple Natures and Forms.

For example; the following are *Conformable Instances;* a Lens, and an Eye; the formation of the Ear, and Places which have an Echo. From this conformity, beside the observation of likeness, which is useful for many things, it is easy to go on to collect and form this Axiom—that the organs of the senses and those bodies which beget reflexions to the senses are of like Nature. Again: the Intellect admonished by this instance rises with no difficulty to some higher and nobler Axiom—namely, to this, that there is no difference between the consents or sympathies of bodies having senses, and of bodies inanimate, and without senses, except that the former have Animal Spirit added to a body fitly arranged for it; while from the latter it is absent. So that there could be as many senses in Animals as there are sympathies in inanimate bodies, if there were perforations in animated bodies to let the Animal Spirit pass through into the member fitly arranged for it, as into its own and proper Instrument. And again, there are as many motions in inanimate bodies, which have no Animal Spirit, as there are senses in animals; although there ought to be far more kinds of motion in inanimate bodies, than senses in animate, because of the small number of the organs of sense. And a very clear example of this is shewn in pain: for there are very many kinds of pain in animals, and various characteristics of it, (as there is one pain of burning, another of intense cold, a third of pricking, another of squeezing, another of stretching, &c.) and it is most certain that all these (as far as motion goes) are present in inanimate bodies; as in wood or stone when burnt, or frozen, punctured or cut, bent or pounded, &c.)—though sensation does not belong to them, by reason of the absence of Animal Spirit.

Again; the Roots and Branches of Plants, wonderful as it may seem to say so, are *Conformable Instances*. For all vegetables swell, and throw out shoots all round both upwards and downwards. Nor is there any other difference between Roots and Boughs than this, that the Root is buried in the earth, and the Boughs are exposed to air and sun. For if any one takes a tender and vigorous Bough of a tree, and turns it towards the earth, it produces directly a Root, not a Bough, even if it be not fixed to the ground. And vice versa; if earth be placed over a Plant, and it be so blocked up by stone or other hard substance, as to restrain it, so that it cannot throw out its leaves upwards, it will put forth Branches into the air downwards.

Again; the Gum of trees, and many kinds of Gems in rocks are *Conformable Instances.* For they are both of them nothing but exudations and filtering of juices; the first, juices of trees, the second, of stones; whence cleanness and brightness are produced in both by a delicate and careful filtering. For from the same cause it arises that the hair of animals is not so beautiful, or of so vivid a colour, as the plumage of many birds; because juices do not filter so delicately through skin as through quill.

Again; the Fins of Fish and the Feet of Quadrupeds are *Conformable Instances;* so are the Feet and Wings of Birds; to which Aristotle has added the four coils in the motion of serpents. So that in the fabric of the Universe the motions of living beings seem for the most part to be effected by four joints or bendings.

Again; Teeth in Beasts, and Bills of Birds are *Conformable Instances;* from which it is clear that in all perfect Animals there flows some kind of hard substance towards the mouth.

Again; the likeness and conformity of Man to a Plant turned upside down is not absurd. For the head is the root of the nerves and faculties of animals; while the seed-bearing parts are lowest, if you do not reckon the extremities of legs and arms. In a Plant, the root (which stands for the head) is regularly placed in the lowest position; the seeds in the highest.

Lastly; this we must ever teach and often admonish; that men's diligence in inquiry and gathering together of Natural History must be forthwith entirely changed, and turned to the contrary of the manner now in use. For up to this time the industry of men has been great, and very curious in marking the variety of things, and explaining the accurate differences of animals, herbs, and fossils, the chief part of which are the mere sport of Nature, rather than serious and of any use towards the Sciences. Such things certainly tend to our enjoyment, and even sometimes to practical use; but little or nothing towards an insight into Nature. And so our labour is to be entirely turned to inquiry into and notice of similitudes and analogies, both in the whole and in the parts of things: for these are they which unite Nature and begin to establish Sciences.

But in these very grave and severe care must be taken, that those things be taken for *Conformable and Proportionate Instances* which denote *physical Similitudes,* as we said at the beginning; i.e. Similitudes real and substantial and deep in Nature, not chance and superficial ones; much less superstitious or curious, such as the writers of Natural Magic, (men of the greatest levity, and scarcely to be mentioned in matters so serious as these we now are treating of,) parade everywhere, describing and even sometimes inventing, with much vanity and folly, empty Similitudes and sympathies of things.

But leaving these things; even in the very figure of the World in its greater parts, *Conformable Instances* are not to be neglected: as Africa, and Peru with the continent which stretches to the Straits of Magellan: for each region has similar Isthmuses, and similar Capes, which is no mere accidental occurrence. So too the New and the Old World are *Conformable* in this, that both Worlds are broad and extended towards the North, but narrow and pointed towards the South.

Again; we have most noble *Conformable Instances* in the intense Cold in the middle region of the air (as they call it) and those most violent Fires which are often found to burst forth from subterranean places: two things which are ends and extremes; i. e. the Nature of Cold towards the circuit of Heaven; the Nature of Heat towards the bowels of the Earth; by "Antiperistasis" or rejection of contrary Nature.

Lastly; in the Axioms of Sciences the *Conformity of Instances* is worthy of notice: just as the figure of Rhetoric called *παρ' ἀπροσδοκητόν* is *Conformable* to the figure of Music called "sliding from the close or cadence." In like manner, the Mathematical Postulate, "those things which are equal to the same, are equal to one another," is *Conformable* to the construction of the Syllogism in Logic; for it unites those Terms which agree in a Middle Term.

In conclusion, a certain sagacity is very useful in most cases, for collecting and hunting out *Conformities* and *Physical Similitudes*.

28. Seventh among Prerogative Instances we will place *Singular Instances;* which we also are wont to call *Irregular* or *Heteroclite* (taking a word from the Grammarians). These are those which exhibit bodies in the concrete; bodies which seem to be extravagant, and as it were abrupt in Nature, and to have very little in common with other things of the same kind. *Conformable Instances* are each like other; *Singular Instances* are each like itself. And the use of them is like that of *Clandestine Instances;* viz. to bring forth and unite Nature for the discovery of Genera, or common Natures, to be limited afterwards by means of true Differences. For we may not desist from inquiry, until the properties and qualities found in things of this kind, and which may be counted as miracles of Nature, are reduced and comprehended under some certain Form or Law; so that all irregularity or singularity be found to depend upon some common Form; while that miracle lies, finally, only in accurate differences, degrees, and uncommon coincidences, not in the species itself: whereas now men's thoughts go no farther than to lay down such things as secrets and mighty deeds of Nature, as things without cause, and as exceptions to general rules.

The Sun and Moon, among Stars; the Magnet among Stones; Quicksilver among Metals; the Elephant among Quadrupeds; the "Sensus Veneris" among the kinds of Touch; the Scent of Dogs among the kinds of Smell; are examples of *Singular Instances.* The letter S, too, is held by the Grammarians to be *Singular;* on account of its ready composition with two, sometimes with three consonants; a thing which no other letter allows.

Instances of this kind are to be accounted of very great value, because they sharpen and enliven inquiry, and cure the Intellect when injured by habit and the common course of things.

29. Eighth among Prerogative Instances we will place *Deviating Instances;* i. e. Errors of Nature, things strange and monstrous, wherein Nature declines and turns aside from her ordinary course. For the Errors of Nature differ from *Singular Instances* in this, that the latter are miracles of *species,* the former, miracles of *individuals.* Their use, however, is almost the same; for they rectify the Intellect against Habit, and reveal common Forms. Nor may we in these desist from inquiry, until the cause of this kind of deviation be discovered. But that cause does not reach to Form properly, but only to the *Latent Process* towards Form. For he who knows the ways of Nature will with greater readiness observe her deviations from the way. And again: he who knows her deviations will describe her ways with the greater accuracy.

And they differ also from *Singular Instances* in this; that they far more assist practice and the active side. For to generate new species would be a very arduous task; but to vary known species, and to produce thence many things rare and unwonted is less arduous. The transition from the miracles of Nature to those of Art is easy. For if Nature is once taken in her variation, and the reason of it is clear; it will be easy to lead Nature by means of Art to that point to which she had wandered by accident. And not only to that point, but to others also: for Errors in one direction shew and open the way to Errors and deflections in every direction.

Here, however, there is no need for examples, on account of the abundance of cases. For a collection or particular Natural History of all monstrosities and prodigious births of Nature must be made; and finally, of all novelties, rarities, and things unwonted in Nature. And this, moreover, must be done with the most severe selection, so as to create confidence. And those are most to be suspected which depend in any way whatever upon Religion—like the prodigies of Livy: and no less those which are found in the writers of Natural Magic, or even of Alchemy, and men of that kind; who are a sort of suitors and lovers of Fables. But our Instances must be drawn from grave and trustworthy History and faithful Narration.

30. Ninth among Prerogative Instances we will place *Frontier Instances;* which we are also wont to call *Participles.* These are those which exhibit such kinds of bodies as seem to be compounded of two kinds, or to be rudiments between two kinds. These can be rightly counted among *Singular Instances,* or

Heteroclites: for they are in the whole system of things rare and extraordinary. Yet for their dignity they are to be treated and placed apart. For they indicate best of all the composition and fabric of things, and suggest causes for the number and quality of the ordinary species in the World, and draw the Intellect from what is to what can be.

Examples of these are; Moss, between corruption and a plant; some Comets, between stars and ignited meteors; Flyingfish, between birds and fishes; Bats, between birds and quadrupeds;

> Simia quam similis, turpissima bestia, nobis;

Biformed Offspring, and Mongrels of different species; and the like.

31. Tenth among Prerogative Instances we will place *Instances of Power*, or *of the Fasces*, taking a word from the insignia of empire; which we are also wont to call the *Wit* or *the Hand of Man*. These are works of greatest nobleness and perfection, and, as it were, the masterpieces in each Art. For as it is the chief thing that Nature should subserve to the affairs and wants of man; it is quite fitting that works which have been now for a long time in man's Power (like provinces before occupied and reduced) should be noted and numbered; especially those which are most polished and perfect: because the passage from these to what is new and hitherto undiscovered is easier and nearer. For if any one be willing earnestly and strenuously to push on his design after attentive contemplation of these works; the result will certainly be that he will

either carry them on far beyond; or turn them to something bordering upon them; or even apply and transfer them to some more noble use.

Nor is this the end. For even as the Intellect is roused and elevated by rare and unwonted works of Nature to inquire into and discover Forms which can contain them, so too this is the case in the excellent and admirable works of Art. Nay it is far more so; for the manner of making and constructing such miracles of Art is for the most part plain; while generally the method is more obscure in the miracles of Nature. Still the greatest care must be taken in these very cases, not to depress the Intellect, and, as it were, fix it to the ground.

For there is a danger lest by works of Art of this kind, which seem like summits and pinnacles of human industry, the Intellect should be astonished and bound down, and bewitched respecting them; and so not be able to familiarise itself to other things, but should think that nothing of that kind can be done, except by those very means which have effected what it admires, if only greater diligence and more accurate preparation be used.

On the other hand, this must be laid down for certain: that the ways and methods of effecting things and producing results, as yet discovered and noted, are for the most part poor and little matters; and that all greater power depends, and is in due order derived from the fountains of Forms, of which none have yet been discovered.

And so, as we have said elsewhere, he who thinks of such machines and battering-rams as the ancients had; even though he did this most earnestly, and spent his life upon it, would yet have never hit upon the discovery of Cannon, acting by means of gunpowder. Nor, again, would he, who had fixed his mind and observation on woollen manufactures and cotton, ever by means of them have discovered the Nature of the Silkworm or of Silk.

Wherefore, all discoveries which can be counted as most noble (if you observe) have come to light not at all through feeble polishing and extension of Arts, but altogether by chance. For nothing imitates or anticipates chance, which is wont only to act at long intervals of ages, except the discovery of Forms.

There is no need to adduce instances in particular of this kind, for there are plenty of them. For this is the course to be followed: Let all Mechanical and even Liberal Arts (as far as they are Practical) be visited and closely examined; and thence there must be made a Collection or Particular History of Great Works and Masterpieces, and of those which are the most perfect in each; together with the modes of carrying them into effect or operation.

And we do not bind down the diligence, which is to be exerted in such a compilation, to those works only which are regarded as Masterpieces and Secrets of each Art, and which excite wonder. For wonder is the offspring of rarity; for what is rare, though in kind it be of a common Nature, excites wonder.

On the contrary, that which is really wonderful by reason of the discrepancy between its species and others, if it be in everyday use, is but carelessly observed. Moreover the *Singular Instances* of Art ought to be observed no less than those of Nature, of which we have before spoken. And just as we placed the Sun, the Moon, the Magnet, &c., things most ordinary, yet almost of a singular Nature, among the *Singular Instances* of Nature; so the same thing must be done with the *Singular Instance* of Art.

For example; Paper is a *Singular Instance* of Art: a common thing enough. If you consider diligently, you will see that artificial materials are either quite woven with woof and warp; like Silk, Wool, Linen, and the like; or are coagulated from concrete juices; like Brick, Earthenware, Glass, Enamel, Porcelain, and the like; which, if well united, are bright; if not, are hard certainly, but take no polish. And yet all those things which are made from concrete juices are brittle, and nohow coherent and tenacious. On the contrary, Paper is a tenacious body, which may be cut and torn; so that it imitates and almost rivals the skin or membrane of animals, or the leaf of vegetables, and such works of Nature. For it is neither brittle like Glass, nor woven like Cloth; but has fibres certainly, not distinct threads, after the fashion of natural materials: so that scarcely anything similar to it can be found among artificial materials, and it is quite *Singular*. And those certainly are to be preferred among artificial works, which approach most nearly to the imitation of Nature, or, on the other hand, powerfully rule her and change her course.

Again; among *Instances of man's Wit, and Hand,* Juggling and Diversions are not entirely to be despised. For some of them, though in use light and ludicrous, yet in information may be valuable.

Lastly; things Superstitious, and (taking the word in its ordinary sense) Magical, are not to be altogether omitted. For though things of this kind be deeply buried beneath a vast heap of lies and fables; yet one must look into them a little, to see if there be not underneath, and hidden in some of them, some natural operation: as in fascination; in the strengthening of Imagination; the sympathy of distant objects; the communication of impressions from spirit to spirit, no less than from body to body; and the like.

32. From the above it is clear that these five Instances just given (the *Conformable, Singular, Deviating, Frontier* Instances, and the Instances of *Power*) ought not to be held back till some certain Nature is under inquiry; (as those we first set forth, and as the most of those yet to follow, ought to be) but a collection of them, like a particular Natural History, is to be made from the beginning; so that they may digest the matter that enters the Intellect, and correct the faulty condition of the Intellect itself; for it must needs be imbued, infected, and at length perverted and distorted by daily and customary impressions.

And so these Instances are to be applied like some preparative, to rectify and cleanse out the Intellect. For whatever leads the Intellect away from what is customary, smoothes and levels its area, for it to receive the dry and pure light of true conceptions.

Farthermore, Instances of this kind prepare and make the way for the operative branch; as we will say in its proper place, when we speak of *Deduction to Practice.*

33. Eleventh among Prerogative Instances we will place *Accompanying* and *Hostile Instances;* which we are also wont to term *Instances of fixed Propositions.* These are such as exhibit some body or concrete, in which the Nature sought for always follows as an individual companion: or on the other hand, from which it always flies, and is excluded from the *company,* as an enemy public and private. For from instances of this kind are formed certain and Universal Propositions, affirmative or negative; in which the subject will be such a body in the concrete, but the Predicate the Nature sought for. Particular Propositions are not at all *fixed;* those, that is, in which the Nature sought for is found floating and moveable in some concrete; viz. as a Nature approaching, or acquired; or receding, or laid aside. Wherefore Particular Propositions have no very great Prerogative, save only in the case of *Migration,* of which we have spoken above. And, nevertheless, even those Particular Propositions, if collated and compared

with Universals, are of great use; as shall be said at the proper place. Nor do we, even in these Universal Propositions, require an exact or absolute affirmation or negation. For it is enough for our purposes, even though they be liable to some single or rare exceptions.

Now the use of *Accompanying Instances* is the narrowing the affirmative of Form. For just as in *Migrating Instances* the affirmative of Form is narrowed; viz. so that the Form of a thing must necessarily be laid down to be something which is introduced or destroyed by that act of *Migration;* so too in *Accompanying Instances* the affirmative of Form is narrowed; in such wise that the Form of the thing must necessarily be laid down as something which enters into such a concrete body; or, on the contrary, which is repugnant to it: so that he who well knows the constitution or structure of such body, will not be far from bringing to light the Form of the Nature sought for.

For example; let the Nature sought for be Heat. An *Accompanying Instance* is Flame. For in Water, Air, Stone, Metal, and very many other substances, Heat is moveable, and can come and go: but all Flame is hot, so that Heat always follows in the concretion of Flame. No *Hostile Instance* of Heat is found among us. For we have no sensible acquaintance with the bowels of the earth; but of the bodies we know there is absolutely no concretion which is not susceptible of Heat.

Again; let the Nature sought for be Consistency:

A *Hostile Instance* is Air. For Metals can be made liquid, or be Consistent: so can Glass, and even Water when frozen: but it is impossible for Air ever to be Consistent, or to put off its quality of fluidity.

But with regard to these *Instances of fixed Propositions*, two pieces of advice, serviceable to our purposes, remain. 1st. That if there is clearly no Universal affirmative or negative, it be diligently noted as non-existent: as we did in the case of Heat, wherein a negative Universal (so far as our knowledge of substances reaches) is wanting in the Nature of things. Similarly, if the Nature sought for be eternal or incorruptible; we have no Universal affirmative within our ken. For eternity or incorruptibility cannot be predicated of any of the bodies below the Heavens, or above the bowels of the Earth. 2nd. That to our Universal Propositions (affirmative or negative) respecting any concrete, there be at the same time subjoined those concretes which seem to approach most closely to what is non-existent; as in Heat, the most gentle and least burning Flames; in Incorruptibility, Gold, which approaches most nearly to it. For all these point out the limits of Nature between entity and non-entity; and help towards circumscribing Forms, so that they may not spread and wander forth beyond the conditions of Matter.

34. Twelfth among Prerogative Instances we will place those *Subjunctive Instances* of which we spoke in a former Aphorism: these we are also wont to call *Instances of Extremes* or *Limits*. For instances of

this sort are not only useful so far as they are subjoined to fixed Propositions; but of themselves also, and in their own Nature. For they mark out not obscurely the true divisions of Nature, and measures of things, and "*How far*" Nature does or allows every thing, and thence her passage to something else. Such are, Gold, in Weight; Iron, in Hardness; the Whale, in size of Animals; the Dog, in Scent; the kindling of Gunpowder, in rapid Expansion, and other things of that kind. And those things which are extremes downwards are to be exhibited as much as those which are so upwards: as Spirits of Wine, in Weight; Silk, in Softness; Skin-worms, in bulk of Animals; &c.

35. Thirteenth among Prerogative Instances we will place *Instances of Alliance* or *Union.* These are such as mingle and unite Natures thought to be heterogeneous, and noted and marked off as such by received divisions.

Instances of Alliance shew that operations and effects which are considered to be peculiar to one of those heterogeneous Natures, belong also to others from among them; so that that heterogeneous Nature, as it is counted, is proved not such truly and essentially; but nothing but a modification of a common Nature. And so they are of the best use for elevating and carrying up the Intellect from Differences to Genera, and for removing spectres and images of things, as they occur and come forth wearing the disguise of concrete substances.

For example; let the Nature sought for be Heat.

There seems to be a thoroughly settled and authentic division of Heat into three kinds: viz. Celestial, Animal, and Igneous: also men hold that these kinds of Heat (especially one of them compared with the other two) are in very essence or species (or specific Nature) different and quite heterogeneous: since both Heavenly and Animal Heat generate, and cherish; but on the contrary Igneous Heat corrupts and destroys. And so this is an *Instance of Alliance*—an experiment common enough:—bring the bough of a vine into a house where there is continual fire, and the grapes ripen consequently even a whole month sooner than they do out of doors: so that fruit even when hanging on the tree can be ripened by fire, a work which seems to belong peculiarly to the Sun. And so from this beginning the mind rises readily, after having rejected the notion of a heterogeneous and essential Difference, to ask, what are those Differences which are really found to exist between the Heat of the Sun and of Fire, from which it results that their operations are so unlike, although they themselves partake of a common Nature.

These Differences will be found to be four; viz. 1. that the Sun's Heat, compared with that of Fire, is in Degree far milder and gentler: 2. that it is (especially as it is brought to us through the Air) far moister: 3. (the chief point) that it is thoroughly unequal, now advancing and increased; now receding and diminished: which mainly contributes to the generation of bodies. For Aristotle rightly asserted that the principal cause of the generation and corruption which take place on the surface of our Earth is the oblique path of the Sun through the Zodiac; whence the Sun's Heat, partly through the changes of day and night, partly through succession of summer and winter, becomes marvellously unequal. But still he cannot rest without forthwith corrupting and depraving what he has rightly discovered. For as, forsooth, the Arbiter of Nature (according to his wont), he very magisterially assigns the cause of generation to the approach of the Sun; and that of corruption to its receding: while both (i. e. approach and receding) afford not separately but indifferently the cause of both generation and corruption, for unequal Heat ministers to the generation and corruption of things; equal Heat only to their preservation. And the 4th Difference between the Heat of the Sun and of Fire is one of very great importance; viz. the Sun insinuates its operations gradually and through long periods of time; while the operations of Fire (man's impatience urging him on) are brought to a conclusion in shorter intervals. Now if any one were carefully to try to temper the Heat of Fire, and to reduce it to a more moderate and gentle degree—which may be easily done in various ways; and then to sprinkle out and mix with it some amount of moisture; and especially if he were to imitate the Sun's Heat in its inequality; and lastly, if he could patiently endure delay—(not indeed so much as is proportionate to the Sun's operations, but still longer than men are wont to admit of in the operations of Fire;) he will easily drive out that notion of heterogeneous Heat: and will either attempt, or equal, or in some cases even surpass the effects of the Sun, by the Heat of Fire. A like *Instance of Alliance* is the revival of Butterflies, when benumbed and almost dead with cold, by slight Heat of Fire: so that you may readily perceive, that it is no more forbidden to Fire to vivify Animals than it is to ripen Vegetables. So too that celebrated discovery of Fracastoro, of applying a pan much heated to the heads of desperate apoplectic cases, acts by clearly expanding the Animal Spirits, compressed and almost extinguished by humours and obstructions of the brain; and excites them to motion, just as fire operates on water or air; and in the result restores life. Eggs too are sometimes hatched by Heat of Fire; so it thoroughly imitates Animal Heat: and there are many other examples of the same kind:—so that no one can doubt but that the Heat of Fire in many subjects can be so modified as to resemble that of the Heavenly bodies and of Animals.

Similarly, let Motion and Rest be Natures sought for. It seems to be an established division, springing from the foundations of Philosophy, that natural bodies either rotate; or proceed in a straight line; or stand still and rest. For there is either Motion without limit, or Rest in a limit, or Translation towards a limit. Now that endless Motion of Rotation seems to belong peculiarly to heavenly bodies: Standing-still or Rest, seems to belong to our globe: while all other bodies (heavy and light, as they are called), if placed out of their natural relative position, are carried in a straight line to masses or gatherings of similar bodies, the light upwards towards the Heavens; the heavy downwards towards the Earth. But this is all only fine talk.

Now an *Instance of Alliance* will be any lower Comet. For this, though far below the Heavens, still rotates. And the fiction of Aristotle, respecting the connection or following of each Comet after some star has been long ago exploded; not only because its reason is improbable, but by the manifest fact of the discursive and irregular Motion of Comets through various parts of the sky.

Again; another *Instance of Alliance* in this subject is the Motion of Air, which in the Tropics (where the circles of Rotation are larger) seems itself to rotate from East to West.

Again; another *Instance* would be the Ebb and Flow of the Sea, if only the waters themselves be found to have a rotatory Motion (slow indeed and scarcely perceptible) from East to West; so, however, that they return twice a day. And so if this be the case, it is clear that that rotatory Motion is not limited to Heavenly Bodies, but is common also to Air and Water.

Farther; the property of light bodies of being carried upwards, rather wavers. And for this, a Water Bubble may be taken for an *Instance of Alliance*. For if there be Air under the Water it ascends rapidly towards the surface, by that Motion which Democritus calls πληγή (a stroke), by which the Water descending strikes and raises up the Air, not by the struggling and striving of the Air itself. And when it has reached the surface of the Water, it is hindered from rising any farther by a slight resistance which it finds in the Water's not immediately permitting discontinuation: so that the desire of Air to rise is very slight indeed.

Similarly, let the Nature sought for be Weight. It is a division thoroughly received, that dense and solid bodies are carried toward the centre of the earth, rare and subtle ones towards the Heavens, as to their own peculiar places. But as to places (though in the Schools such things may have weight) it is a thoroughly foolish and puerile conception to think that there is any such peculiar place. And so Philosophers trifle when they say that were the earth bored through, heavy bodies would stop on arriving at the centre. For surely this would be a powerful and efficacious kind of Nothing or of Mathematical Point, affecting bodies, or being sought by them: but body is not acted upon save by body. But that appetite of ascent and descent is either in the structure of the body moved, or in its sympathy and consent with another body. If there be found any dense and solid body which, nevertheless, is not carried to the ground; this division is confuted. But if Gilbert's opinion be received, viz. that the earth's magnetic power of attracting heavy bodies does not extend beyond the circuit of its influence (which operates to a certain distance always, and no farther), and if this be verified by some instance, such would be an *Instance of Alliance* on this subject. But at present no certain and clear instance of this occurs. Water-spouts, often visible as men sail through the Atlantic towards either Indies, seem to approach most nearly to one. For so great does the violence and mass of water suddenly sent forth from them appear, that it seems to have been gathered previously, to have stopped and remained in those parts, and afterwards to have been cast and thrust down by some violent cause, rather than to have fallen by the natural motion of gravity: and so it may be conjectured, that a bodily mass, dense and compact, at a great distance from the earth, may be suspended as much as the earth itself is; and would not fall unless cast down. But as to this we make no positive assertions. Meanwhile, both in this and in many other cases it will very readily appear how poorly off we are for Natural History: when in place of certain instances we are sometimes obliged to put forward suppositions as examples.

Similarly, let the Discursive Faculty of the Mind be the Nature sought for. The division into human reason, and the instinct of brutes, seems to be quite true. And yet there are some instances of actions performed by brutes, by which even they seem almost to syllogise. As is told of the Crow, which, when nearly perishing of thirst in a time of great drought, espied some water in the hollow trunk of a tree; and as it could not get in through the narrowness of the opening, it never left off throwing in pebbles till the water so rose that it was able to drink;—and it afterwards became a proverb.

Similarly, let the Visible be the Nature sought for. There seems to be a very true and certain division into Light visible originally, and conferring the power of vision, and Colour visible secondarily, and not perceptible without Light, so that it seems to be nothing but an image or modification of Light. And yet there seem to be *Instances of Alliance* on both sides on this subject; i. e. Snow in great quantity, and Flame of sulphur; in the one there seems to be Colour first turning into Light; in the other Light verging towards Colour.

36. Fourteenth among Prerogative Instances we will place *Crucial Instances:* a name transferred from the crosses (or fingerposts) which are put up in crossways to mark and point out the different ways. We are also wont to call them *Decisive* and *Judicial Instances*, and in some cases *Instances of the Oracle* and *of Command.* They are of this kind: when in inquiry into any Nature the Intellect is put into a sort of equilibrium, so that it is uncertain to which of two or sometimes more Natures the cause of the Nature inquired into ought to be attributed or assigned, on account of the frequent and ordinary concurrence of more Natures than one; the *Instances of the Cross* shew that the union of the one Nature with the Nature sought for is faithful and indissoluble; while that of the other is varied and separable; whence the question is limited, and that first Nature is received as the Cause, the other is

sent off and rejected. And so instances of this kind are of the greatest light, and of great authority; so that the course of interpretation sometimes comes to a close at them, and is perfected by them. Sometimes *Crucial Instances* occur and are found among those already noticed; but for the most part they are new, and purposely and expressly sought out and applied, and brought to light at length by sedulous and active diligence.

For example; let the Ebb and Flow of the Sea, repeated twice a day, six hours of Ebb, and six of Flow, with some difference which coincides with the Moon's motion, be the Nature sought. There will be here the following cross-way.

It is quite necessary, that this motion be effected either by the advancing and retiring of the waters, like water shaken in a basin, which when it washes one side leaves the other; or by the rising and falling of the waters from the bottom, like water which bubbles up and subsides again: the question springs up, to which of these two ought that Ebb and Flow to be assigned. Now, if the former of the assertions be received, it is necessary that when the tide is upon one side, it should be down at the same time somewhere else in the sea. And so the inquiry is reduced to this. Now Acosta, and some others, after diligent inquiry, have observed that on the shores of Florida, and the opposite shores of Spain and Africa, the tide ebbs and flows at the same time; not, on the contrary, ebbing on one side and flowing on the other. And yet hitherto, if one considers it carefully, the rising and falling motion is not proved, nor is the progressive refuted.

For the motion may be progressive, and yet inundate opposite sides of the same Channel at once; that is, if the waters be thrust or driven together from some other part; as is the case in rivers, which ebb and flow on both banks at the same hour, while still their motion is clearly in progress, the waters entering the rivers' mouths from the sea. And so similarly it can be that waters coming in great body from the Eastern Indian Ocean are driven and thrust into the channel of the Atlantic, and therefore inundate both shores at once. And so the question is, whether there is some other channel, through which the waters are ebbing and flowing at the same time (on the opposite shores). And we have at hand the Southern Ocean, in no way less than the Atlantic, but rather wider and more extended, and so it may suffice for our requirements.

And so we have now at last arrived at a *Crucial Instance* on this subject. It is this: If it be found for certain that when the tide flows on the opposite shores of Florida and Spain, in the Atlantic, it at the same time flows on the shores of Peru, and near the back part of China, in the Southern Ocean: then the assertion that Ebb and Flow of the sea are caused by progressive motion, must certainly be rejected through this *Decisive Instance.* For there is no other sea or place left at which there can be retreat or Ebb of tide at the same time. And this can be learnt most readily by inquiring of the inhabitants of Panama and Lima, (where both the Oceans, the Atlantic, and the Southern, (or Pacific,) are separated only by a narrow Isthmus,) whether on both sides of the Isthmus the tide ebbs and flows at the same time or not. And this decision or rejection seems to be certain, if you lay it down that the earth is stationary. But if the earth rotates, it may perhaps turn out that from the unequal rotation of the earth and of the waters of the sea (in respect of rapidity or force of velocity) there follows a violent forcing of the waters upwards into a heap—which would be the Flow—and then a recoil of them (when they can no longer bear the accumulation) downwards—which would be the Ebb. But on this, separate inquiry must be held. And even on this supposition it remains equally fixed, that somewhere there must be Ebb at the same time that there is Flow in other parts.

Similarly; let the Nature sought for be that latter of the two kinds of motion supposed; viz. the rising and falling motion of the Sea; if by chance it should so happen that after diligent examination that first-mentioned progressive motion be rejected. Then there will be three ways for this Nature. It is necessary that this motion, by means of which water rises and falls in Flow and Ebb without any accession of water running towards it, should take place in one of the following three ways; (1) either that this abundance of water flows forth from the interior of the earth, and again retires into it; or

(2) that the quantity of water is no greater, but that the same water (without increase of quantity) is extended or rarified so as to fill a greater space, and again is contracted; or (3) that there is no addition to quantity, nor wider extension; but that the same waters (just as they are, both in quantity, and density or rarity) rise and fall through the agency of some Magnetic power which attracts them from above, calls them forth, and acts by sympathy. And so, if you please, let the inquiry be reduced to this last kind of motion, (passing over the other two before mentioned) and let the question be, whether any such rising of water by sympathy or Magnetic force can take place. But first it is manifest, that the water as it lies in the trench or hollow of the sea cannot all rise together, for then there would be none to fill up the bottom; so that if there were in the water any such desire of rising, yet the same would be broken and restrained by the connection of things, and the "abhorrence of a vacuum," of which people commonly speak. It remains, then, that the water must rise on one side, and so be diminished and fall on the other. And so again it must follow, that this Magnetic power, as it cannot operate on all the surface, must operate most intensely upon the middle; so as to raise the water there, and so by being higher there, as the water goes in that direction, it deserts and leaves bare the shore.

And so we have now arrived at a *Crucial Instance* in this subject. It is this: If it be found that in the Ebb the surface of the sea is more convex and round, as the waters rise towards the middle, and fall towards the sides, i. e. the shores; and that in the Flow, the same surface is more flat and level, as the waters return to their former position; then certainly, by this *Decisive Instance*, the raising of them by Magnetic power can be received: if this be not the case, it must be entirely rejected. This, however, there would be no difficulty in trying in shallow seas by means of sounding lines; viz. whether the water is not deeper in the middle of the sea at low than at high tide. Moreover it must be noted, that if this be the case, (the contrary to what people believe,) in Ebb the waters rise, but in the Flow they fall so as to cover and inundate the shores.

Similarly, let the Nature sought for be Spontaneous Motion of Rotation; and specially, whether the daily Motion by which Sun and Stars rise and set in our sight, is a true Motion of Rotation in the Heavens; or an apparent Motion in the Heavens, but a real one upon the earth. There can be the following *Crucial Instance* on this subject. If there be found to be any Motion in the Ocean from East to West, however languid and feeble, if this same Motion be found a little more rapid in the Air, especially between the Tropics, where it is more perceptible by reason of the larger circles: if the same Motion be found in the lower Comets, and be lively and strong in them: if the same be found in the Planets, yet so tempered and graduated that the nearer to earth the slower; the farther, the faster; and finally in the Starry Heavens it be most swift of all: then certainly the Diurnal Motion in the Heavens must be received as true, and that of the earth must be rejected: because it will be manifest, that the Motion from East to West is entirely Cosmical, and arises from the harmony of the Universe, since it is most rapid in the highest Heavens, gradually declines, and finally ceases, and is extinguished at the immoveable, sc. at the Earth.

Similarly, let the Nature sought for be that other Motion of Rotation, so famed among Astronomers, which is antagonistic and contrary to the Diurnal Motion, from West, that is, to East, and which the old Astronomers attribute to the Planets and even to the Starry Heavens. But Copernicus and his followers attribute it to the Earth as well; and let inquiry be made as to whether there is found in the Nature of things any such Motion, or whether it is a thing feigned and assumed for ease and advantage of calculation; and for that fair scheme of effecting the heavenly Motions by means of perfect circles. For this Motion is by no means proved to be true and real in the higher heavenly bodies, by defect of return of the Planets in their Diurnal Motion to the point in the Starry Heavens whence they set out; nor is it proved by difference of the Poles of the Zodiac from the Poles of the Earth; which two things have begotten this Motion. For the first Phenomenon is best solved by precedence and dereliction; the second, by spiral lines; so that the inequality of return and declination to the Tropics can be rather modifications of that only kind of

Diurnal Motion than antagonistic Motions or Motions round different Poles. And it is most certain, if we consider ourselves for a while as siding with the vulgar, (dismissing the fictions of the Astronomers and the schools, whose wont is unjustly to offer violence to the senses in many cases, and to prefer what is obscure,) that the Motion is to the senses such as we have said: and we once caused the similitude of it to be represented by iron threads, as in a machine.

But the *Crucial Instance* in this case may be as follows. If there be found in any trustworthy History that there has been a Comet, higher or lower, which did not rotate in evident harmony (though very irregularly) with the Diurnal Motion, but rather rotated towards the opposite side of the Heavens, then certainly it must be judged thus far, that there can be in Nature some such Motion. But if nothing of this kind is discovered, it is to be suspected, and we must betake ourselves to other *Crucial Instances* on this subject.

Similarly, let the Nature sought for be Weight or Gravity. As to this there is the following crossway. It is necessary that Heavy and Weighty Bodies should either tend by their own Nature to the centre of the earth, by reason of their own structure; or that they should be attracted and hurried by the corporeal mass of the earth, as by a collection of homogeneous bodies, and be carried to it by sympathy. If the latter of these be the case, it follows that the nearer they approach the earth the more strongly and with the greater impulse are they borne towards it; the farther they are from it, the more feebly and slowly, as is the case with Magnetic Attractions, and that this must take place within certain limits; so that if they were removed to so great a distance from the earth, that its virtue could not act, they would remain in suspense, just as the earth does itself, and would not fall at all.

And so there can be the following *Crucial Instance* upon this subject. Take one of those Clocks, which are moved by leaden weights, and also one of those which are moved by a spring; let them be fairly tested, so that neither shall go faster or slower than the other; then let the Clock which goes by weights be placed on the summit of some very lofty church, while the other is kept below; and let diligent note be made as to whether the Clock above goes more slowly than it used in consequence of the diminished power of the weights. So too let experiment be made in the bottom of mines deep below the surface; and see whether such a Clock does not go more quickly than it used, because of the increased power of the weights. But if the weight be lessened at a height and increased beneath the earth, then let attraction by the corporeal mass of the earth be received as the cause.

Similarly, let the Nature sought for be the Polarity of the Magnetic Needle. Respecting this there will be the following cross-way. It is necessary that the touch of the Magnet should of itself communicate

Polarity towards North and South to the iron; or only rouse it and make it capable, while the motion itself is communicated by the presence of the earth, as Gilbert thinks, and endeavours to prove with so great earnestness. The cases he has gathered with ingenious industry support this view: viz. that an iron bolt, placed for a long time towards North and South, gains Polarity by its long continuing, without the touch of the Magnet: just as if the earth itself, though it acts weakly from its distance, (for the surface or outer crust of the earth is devoid, as he holds, of Magnetic power,) yet after a long time supplies the want of the Magnet, and first rouses, then conforms and changes the iron. Again, that iron ignited and red-hot, if as it is cooled it be stretched out North and South, also gathers Polarity without the touch of the Magnet: just as if the parts of iron set in motion by ignition, and afterwards recovering themselves, were more susceptible, and, (so to speak,) sensitive of power emanating from the earth, at the moment of their cooling, than at any other time; and so became in a way excited. But these points, though well observed, yet do not thoroughly prove his assertion.

The following may be a *Crucial Instance* on this subject. Take a little Magnetic Globe;—mark its Poles; place them towards the East and West, not the North and South, and so let them lie: then put upon it an untouched Needle, and let it be left there six or seven days. The Needle (on this there is no doubt) while it remains over the Magnet will desert the Poles of the Earth and turn to those of the Magnet. And so long as it so remains, it turns towards the East and West of the world. Now if this Needle be found, when removed from the Magnet and placed on a pivot, to turn directly to the North and South, or even gradually to return thither; then the presence of the Earth must be taken as the cause: but if, on the other hand, it turns (as before) to the East and West, or loses its Polarity, that cause must be suspected, and farther inquiry be made.

Similarly; let the Nature sought for be the Corporeal Substance of the Moon; whether it be subtle, a flame, or air, as most of the old Philosophers thought; or solid and dense, as Gilbert and many Moderns, with some Ancients, hold. The reasons for this latter opinion are founded chiefly on this, that the Moon reflects the Sun's rays; and no reflection of light seems to take place except from solid bodies.

And so in this case the *Crucial Instances* will be (if there be any) those which prove reflection from a subtle body like flame, so long as it is of a sufficient density. Certainly one cause of twilight (among others) is the reflection of the Sun's rays from the upper Air. Also we sometimes see the Sun's rays reflected in calm evenings from fringes of dewy clouds, of brightness not less, but rather more brilliant and glorious, than those which are reflected from the body of the Moon; and yet it is not certain that those clouds have formed into a dense body of water.

We see too that the dark air behind windows reflects by night the light of a candle, as much as a dense body would. And the experiment might also be tried of letting in the Sun's rays through a hole upon some darkish blue flame. Certainly the free rays of the Sun falling on dim flames seem to deaden them, so that they appear more like white smoke than flame. And these instances occur at present as *Crucial* on this subject; perhaps better ones can be found. But it is always to be noted that reflection from flame is not to be looked for except from flame of some depth: for otherwise it approaches transparency. But this must be laid down for certain, that light upon a level surface is always either received into it and transmitted, or reflected from it.

Similarly; let the Nature sought for be the Motion of Missiles; as of darts, arrows, balls, through the air. This Motion present Philosophers (after their wont) treat very negligently; holding it as enough if a distinction be made between violent and natural Motion (as they call it); and as to the first impact or impulsion, satisfying themselves by the formula that "two bodies cannot be in one place, or there would be a penetration of dimensions:" and they care nothing for the continued progress of this Motion. But as to this Nature there is the following cross-way. Either this Motion is caused by the air carrying on the body projected, and gathering behind it, as a river does with a boat, or wind with straw; or by the parts of the body itself, which cannot bear the pressure, but push themselves forward in succession to lessen it. Fracastoro, and almost all those who have made subtle inquiry about this kind of Motion, have received the former solution: nor is it doubtful that air has some share in the matter; but the other kind of Motion is undoubtedly the true one, as appears from an infinite number of experiments. But among the rest there may be the following *Crucial Instance* on this subject; viz. that a thin iron plate or somewhat stiff iron wire, or even reed or pen cut in the middle, when drawn together and bent between the finger and thumb, leap up. For it is manifest that this cannot be attributed to air gathering behind the body, because the source of Motion is in the middle of the thin plate or pen, not in the extremities.

Similarly; let the Nature sought for be the rapid and powerful Motion of Expansion of Gunpowder into flame: whence so great masses are upheaved, so great weights projected, as we see in large Mines and Cannon. Respecting this Nature there is the following cross-way. Either this Motion is roused by the mere appetite of the body as it expands, after it has been set alight; or by the mixed appetite of crude Spirit, which rapidly escapes from fire, and bursts forth violently from the surrounding flame, as from a prison. Philosophers, however, and common opinion think only of that first kind of appetite. For men think they are playing the philosopher finely, if they assert that flame, from the Form of the element (of fire), is gifted with a sort of necessity of occupying a larger space than the same body did while under the form of powder; and that this Motion follows thence. Meanwhile they do not at all consider that though this be true (granting that a flame is generated), yet that the generation of flame can be impeded by a mass great enough to compress and stifle it; so that the thing is not brought to that necessity of which they speak. For they think rightly that there must be some Expansion, and that thence projection or removal of the opposing body ensues, if flame be generated. But that necessity is clearly avoided, if that solid mass suppresses the flame before it is generated. And we see that flame (especially at the beginning of its generation) is soft and gentle, and requires a cavity in which it can play and try its strength. And so, so great violence cannot be assigned to it of itself. But this is true—that the generation of exploding flames of this kind, or (as one may call them) fiery winds, arises from the conflict of two bodies whose Natures are clean contrary; the one very inflammable (a Nature which flourishes in Sulphur); the other hating flame (like the crude Spirit in Nitre): so that there results a wonderful conflict between the Sulphur which kindles violently, (for the third body, Charcoal, has hardly any other part but that of incorporating and conveniently uniting those two bodies) and the Spirit of Nitre which bursts forth as far as possible, and expands at the same time, (for air also, all crude substances, and water, do this, when expanded by Heat,) and which the while, by this flight and eruption on all sides, fans the flame of Sulphur as it were by invisible bellows.

There can be two kinds of *Crucial Instances* on this subject. The one is of those bodies which are most inflammable, like Sulphur, Camphor, Naphtha, and the like, with their combinations; which take fire more swiftly and readily than Gunpowder, if they be not hindered: whence it is plain that the desire of catching fire does not produce this tremendous effect. The other is of those substances which avoid and abhor flame, as all Salts. For we see that if they be cast into fire the watery spirit bursts forth with a noise before flame is kindled: a thing which also happens slightly in stiff leaves, from which the watery part bursts forth before the oily takes fire. But this is best seen in Quicksilver, which is not ill termed Mineral Water. For this, without taking fire, simply from discharge and expansion, almost equals Gunpowder in its strength: and if mixed with Gunpowder it is said to multiply its strength.

Similarly; let the Nature sought for be the Transient Nature of Flame, and its Instantaneous Extinction. For the Nature of Flame does not seem to be here among us fixed and constant, but to be generated every instant and immediately extinguished. For it is clear in Flames, which continue and endure, that this duration is not that of the same individual Flame, but arises from the succession of new

Flames consecutively generated, and that the self-same Flame does not at all remain; a thing which is readily perceived from this, that if the aliment or fuel of Flame be withdrawn, the Flame straightway perishes. On this Nature there is the following cross-way. Its instantaneous Nature arises either from the failure of the cause which first begot it, as in the case of Light, Sound, and violent Motions (as they are called), or because, though Flame in its own Nature can remain here with us, yet it suffers violence from and is destroyed by the contrary Natures around it.

And so there can be the following *Crucial Instance* on this subject. We see how high Flames rise in great Conflagrations;—for the broader the base of the Flame, the higher is its vertex: and so the beginning of the extinction seems to arise at the sides, where the Flame is compressed by air, and is in evil case. But the centre of the Flame, which the air does not touch, but is surrounded by other Flame, continues identically the same; and is not extinguished until it is gradually narrowed by air around its sides. And so all Flame is pyramidal, broader at the base around the fuel, and more pointed at its vertex (for air opposes, and the fuel does not help); while smoke, which is narrower at its base, expands as it rises, and becomes a kind of inverse pyramid; because air admits smoke, while it represses Flame;—for let no one dream that kindled Flame is air, as they are entirely heterogeneous bodies.

There can be a more accurate *Crucial Instance* fitted for this subject, if the thing can be shewn by means of Flames of two colours. Take then a little metal sconce: place in it a small lighted wax candle: place the sconce in a saucer, and pour round it a moderate quantity of spirits of wine, so as not to touch the edge of the sconce: then light the spirits of wine. Now this will shew a blueish Flame, the candle a yellower one. And so let observation be made as to whether the Flame of the candle (which can readily be distinguished by its colour from the Flame of spirits of wine; for Flames, like liquids, do not mix immediately) remains pyramidal, or rather tends more to the form of a globe, when there is nothing to destroy or repress it. If the latter result follows, it must be laid down as certain that Flame remains identically the same so long as it is enclosed within other Flame, and does not feel the hostile power of air.

And let this suffice for *Crucial Instances*. We have been longer treating of them to this end, that men may gradually learn and accustom themselves to judge of Nature by *Crucial Instances* and light-bringing experiments, and not by probable reasonings.

37. Fifteenth among Prerogative Instances we will place *Instances of Divorce;* which indicate the separations between those Natures which most frequently occur. They differ from those subjoined to the *Accompanying Instances:* for those indicate the separations of some Nature from some concrete with which it is usually found in conjunction: while these

indicate the separations of one Nature from another. They differ also from *Crucial Instances;* because they determine nothing, but only advise us concerning the possibility of separating one Nature from another. Their use is to expose false Forms and scatter foolish thoughts springing from obvious things; so that they add, as it were, lead and weights to the Intellect.

For example; let the Natures sought for be those four which Telesio terms *Comrades*, and, as it were, of the same Chamber: viz. Heat, Light, Subtilty, Mobility, or readiness for Motion: many *Instances of Divorce* are found between them. For Air is subtle and fit for Motion, not hot or bright: the Moon is bright, and without Heat: boiling Water is hot without Light: the Motion of the Needle on a pivot is swift and agile, and yet in a cold, dense, opaque body: and many more of the same kind.

Similarly; let the Natures sought for be Corporeal Nature and Natural Action. The latter seems not to be found except subsisting in some body. And yet perhaps there may be an *Instance of Divorce* on this subject. Such would be Magnetic Action, by which iron is attracted to the Magnet, and heavy bodies fall to the earth. There may also be added some other operations at a distance. For such Action takes place in time, in successive moments, not instantaneously; and in place, by degrees and spaces. There is then, some moment of time, and some interval of space, in which that power or Action is suspended (as it were) between those two bodies which cause motion. And so our consideration is reduced to this; whether those bodies which are the extremes of motion displace or alter the intermediate bodies, and thus the power passes by succession and true touch from one extreme to the other, and meanwhile subsists in the intermediate body; or whether there be nothing, save the bodies, the power, and space. And in Optical Rays, in Sounds, and Heat, and some other things which operate at a distance, it is probable that the intermediate bodies are displaced and altered: and the more so, because there is needed a medium fitted to transmit such an operation. But the Magnetic or attractive power allows of indifferent media, and its power is not hindered in any medium. But if that power or Action has nothing to do with the medium, it follows, that there is Natural power or Action for a certain time, in a certain place, subsisting without body: since it neither subsists in the extreme bodies, nor in the media. Wherefore Magnetic Action may be an *Instance of Divorce*, between Corporeal Nature and Natural Action. To this the following can be added, as a Corollary or advantage not to be neglected: viz. that it can even be used against sensuous Philosophers, as a proof that there are entities and substances which are separate and incorporeal. For if Natural power and Action, emanating from a body, can subsist, for a certain time and in a certain place, entirely without body; it nearly proves that it may emanate in its origin from an incorporeal substance. For Corporeal Nature seems to be quite as much wanted to sustain and carry on Natural Action, as to arouse or generate it.

38. Next follow five classes of Instances, which we are wont to call by one general title, *Instances of the Lamp*, or of *first Information*. These are such as aid the senses. For since all *Interpretation of Nature* begins with the senses, and from the perceptions of the senses, by a straight, fixed, and well-made road, leads to Intellectual perceptions, which are true conceptions and Axioms; it is necessary that the more plentiful and exact are the representations or examples afforded by the senses, the more easily and fortunately will all things turn out.

Now of these five classes of *Instances of the Lamp*, the first strengthen, enlarge, rectify the immediate operations of sense: the second bring that which was not an object of sense to be such: the third indicate the continued process or series of those things and motions, which (for the most part) are not noted except at their end or periods: the fourth supply the absolute wants of the senses: the fifth rouse the attention and observation of the senses, and at the same time limit the subtilty of things. But we must now speak of them singly.

39. Sixteenth among Prerogative Instances we will place *Instances of the Door or Gate:* for we so term those which help the immediate operations of the senses. It is clear that Vision holds the chief place among the senses, as far as information is concerned; wherefore help is chiefly to be sought for this sense. Now possible helps seem to be three;

(1) help to perception of objects invisible to the naked eye; (2) to perception of objects at a great distance; (3) to a more exact and distinct perception.

(1) Of the first kind (omitting spectacles, and the like, which are only useful to correct and remove the weakness of a defective vision, and so give no farther information) are those Microscopes lately discovered, which shew us the latent and invisible minutiæ of bodies, their hidden structures and motions, by wonderfully increasing the size of objects. By their means the exact figure and lineaments of bodies, the colours too, and previously not noticeable motions of a flea, a fly, or worm, are discovered with astonishment. Farthermore, they say that a straight line made with pen or pencil is perceived by Microscopes to be very uneven and tortuous: because neither the motions of the hand, even when aided by a ruler, nor the impression of ink or colour are really quite even; although these inequalities are so minute, that they are invisible without the help of such Microscopes. And men have added a certain superstitious observation on this subject—(as is common in new and strange matters) viz. that Microscopes glorify the works of Nature, but dishonour those of Art. But this is nothing more than that natural textures are far more subtle than artificial ones are. For these Microscopes are useful only for minute objects; and Democritus would perhaps have exulted, had he seen such, thinking that a method of seeing the Atom, which he strongly affirmed was invisible, had been discovered. But

the inadequacy of such Microscopes, except for minutiæ only, (and not even for them, if they be in a large body,) destroys the use of the thing. For if the discovery could be extended to larger bodies, or their particles; (so that the texture of a piece of cloth could be looked at like a net, and latent particles and inequalities of gems, liquids, urines, blood, wounds, and many other things, be perceived;) then doubtless great advantage might be reaped from this invention.

(2) Of the second kind are those Telescopes which Galileo invented with memorable exertion. By their help, as by means of boats and shallops, nearer commerce and intercourse can be opened and carried on with the heavenly bodies. For by them it appears that the Milky Way is a knot or collection of little stars, clearly marked and distinct: of which the ancients had only a suspicion. By them it seems to be proved that the "spaces between the Planetary Orbits" (as they call them) are not entirely destitute of other stars; but that the Heavens begin to be full of stars, before arriving at the Starry Heavens themselves: although these are stars too small to be visible without Telescopes. By them one may look into those bands of small stars around the planet Jupiter; whence it can be conjectured, that there are more centres than one in the motions of stars. By them the luminous and opaque inequalities on the Moon's surface are more distinctly perceived and mapped; so that there can be a kind of Selenography. By them spots in the Sun, and the like, are seen;—noble discoveries all of them,

so far as demonstrations of this kind can be safely trusted. I am most inclined to suspect them, because experiment rests in these few discoveries, and because no number of others, equally worthy of investigation, has been made by the same means.

(3) Of the third kind are Measuring Rods, Astrolabes, and the like: these do not increase our sense of sight, but rectify and direct it. If there are other instances to help the other senses in their immediate and individual operations, unless they add something more than is already possessed to our information, they make nothing for our purpose. And so we have not mentioned them.

40. Seventeenth among Prerogative Instances we will place *Citing Instances*, (to borrow a term from the Law Courts,) because they *cite* those things to appear which before did not: these we also term *Evoking Instances.* These bring that which is not sensible into the reach of the senses.

Objects escape the senses, either because of their distance; or because of the interception of the senses by intermediate bodies; or because the object is not capable of making impression on the senses; or because there is not enough quantity in the object to strike the senses; or because there is not time enough to act upon the senses; or because the impression of the object is not permitted by the senses; or because some object has previously filled and possessed the senses, so that there is no room for new motion. And these belong chiefly to sight, and then to touch. For these two senses give information at large, and upon general objects; the remaining three hardly give information at all, except immediately and on their proper objects.

In the first class there can be no reduction to the senses, unless to things not discernible because of distance another thing be added or substituted, which can call forth and strike the senses from a greater distance: as in communicating intelligence by fires, bells, and the like.

In the second class reduction takes place when those things which lie hid within by reason of the interposition of bodies, and cannot be readily laid open, are brought before the senses by those things which are on the surface, or flow forth from the interior: as the condition of the human body is brought forth by the pulse, urine, and the like.

But the reductions of the third and fourth class refer to many subjects, and are to be gathered from all parts in the inquiry after things. Of this the following are examples. It is clear that Air, Spirit, and things of the kind, which are corporeally fine and subtle, can neither be seen nor touched. Wherefore in inquiry on bodies of this kind, there is clear need of reductions.

And so let the Nature sought for be the Action and Motion of Spirit enclosed in tangible bodies. For every thing tangible that we know of contains an invisible and intangible Spirit, and covers and seems to clothe it. Hence that powerful triple source (of effects) and wondrous *process* of Spirit in a tangible body. For Spirit in a tangible thing,

(1) if emitted, contracts and dries up bodies; (2) if retained, softens and melts them; (3) if neither entirely emitted, nor entirely retained, models them, gives them limbs, assimilates, carries them out, organises them, &c. And all these things are reduced to the reach of the senses by conspicuous effects.

For in every inanimate tangible body the Spirit shut in first multiplies itself, and seems to feed on those tangible parts which are most ready and prepared for it; and digests them, works them, and converts them into Spirit, and then they evaporate together. And this making and multiplying of Spirit is brought under cognisance of the senses by diminution of weight. For in all drying, something is lost of the quantity, not only of the Spirit which previously existed in it, but of the body which was before tangible and has been newly changed: for Spirit has no weight.

The egress or emission of Spirit is brought under cognisance of the senses in rust of metals and other putrefactions of that kind, which stop before they have reached the rudiments of life, (which belong to the third kind of *process*.) For in more compact bodies Spirit finds no pores and passages, through which to escape; and so is compelled to force out and drive before itself the tangible parts as well, so that they go out with it; and thence come rust, &c. The contraction of tangible parts, after some of the Spirit has been emitted (whence that drying follows) is brought under cognisance of the senses by the increased hardness of the thing, and far more by clefts, contractions, shrivelling, and folds of the bodies, which ensue. For the parts of wood split and contract, skins shrivel; and not that only, but (if the emission of Spirit be quickened by Heat of fire) contract so hastily that they twist and roll themselves up. On the other hand, when the Spirit is retained, and still is expanded and roused by Heat or anything analogous thereto, (as is the case in more solid or tenacious bodies,) then bodies are softened—as redhot iron; they melt, like metals; liquefy, like gum, wax, and the like. And so these contrary operations of Heat (some things being hardened, others softened by it,) are easily reconciled; because in the former the Spirit is emitted; in the latter, is agitated and retained: the latter of these is the proper action of Heat and Spirit; the former, the action of tangible parts only on occasion of the emission of Spirit.

But when the Spirit is neither entirely retained nor entirely emitted; but only struggles and strives against its bonds, and has obtained some tangible parts which are obedient to it and follow it readily: (so that whithersoever the Spirit leads, they follow it;) then indeed results the fashioning of an organic body, the making of limbs, and the other vital actions in vegetables, as much as animals. And these things are best brought under cognisance of the senses by diligently marking the first commencements and rudiments, or endeavours after life in animalcules born from putrefaction, as in the eggs of ants, worms, flies, frogs after rain, &c.

There is also required for production of life both gentle Heat and a pliant body; so that the Spirit neither bursts forth in its haste, nor is restrained by the obstinacy of the parts: but can rather bend and fashion them like wax.

Again; that most noble difference of Spirit, and which affects most things (viz. unconnected Spirit; simply branching; branching and cellular at the same time; the first of which is the Spirit of all inanimate bodies; the second, that of vegetables; the third, that of animals;) is placed almost before our eyes by a multitude of reducing instances.

It is similarly clear, that the more subtle textures and structures of things thoroughly visible or tangible, are neither perceptible nor tangible. Wherefore in these too our information proceeds by this reduction. The most radical and primary difference between structures is drawn from the plenty or paucity of matter within the same space or dimensions. For the other structures (which are referred to the dissimilarity of parts contained in the same body, and to the collocation and placing of the same) are secondary in comparison with the former.

Let therefore the Nature sought for be the Expansion or Contraction of Matter in different bodies respectively: viz. what quantity of Matter fills a corresponding quantity of space in each. Now there is nothing truer in Nature than the twofold Proposition, "Ex nihilo nihil fieri," and "Nihil in nihilum redigi;" but the actual quantity or sum total of Matter is constant, and neither increases nor diminishes. Nor is this Proposition less true; that "of this quantity of Matter more or less is contained within the same spaces or dimensions, according to the difference of bodies,"—as in water more, in air less: so that if any one were to assert that a given content of water can be turned into an equal content of air, it is equivalent to saying that something can be reduced to nothing; on the other hand, if any one were to assert that a certain content of air can be turned into an equal content of water, it is equivalent to saying that something can come from nothing. And from this plenty and want of Matter the conceptions of Density and Rarity, taken in various and promiscuous ways, are properly abstracted. And a third assertion is to be assumed,—one also certain enough,—namely, that this greater or less quantity of Matter in this or that body (of which we are speaking) can be reduced (after comparison) to calculation and exact, or nearly exact, proportions. E. g. if one were to say that there is in a given content of gold such a collection of Matter, that one must have twenty-one times its bulk in spirits of wine to equal its quantity of Matter, he would not be wrong.

The accumulation of Matter and its ratios are reduced to the cognisance of the senses by weight. For weight answers to the quantity of Matter, as regards the parts of a tangible body; but Spirit and its material quantity are imponderable, for they lessen weight rather than increase it. We have made a tolerably accurate table of this thing, wherein we have selected the weight and bulk of each kind of Metal, principal Minerals, Woods, Liquids, Oils, and very many other bodies both natural and artificial; a thing of much use both for light of information and for rule of operation; and one too which may reveal many things quite unexpectedly. Nor is this to be counted of small importance, that it shews that all variety in tangible bodies known to us (we mean bodies well united, not spongy, hollow, and to a great extent filled with air) does not exceed the ratio of twenty-one to one: so finite is Nature, or at least that part of it which we are most accustomed to make use of.

We also have thought it worthy of our diligence to try whether the ratios of intangible or pneumatic bodies to tangible ones can be arrived at. And we attempted it by means of the following contrivance. We took a glass Phial, which might perhaps hold an ounce; using a small vessel in order that the consequent evaporation might take place with a small amount of Heat. We filled it with spirits of wine almost to the neck, choosing spirits of wine because we observed (by means of the Table just mentioned) that it was the most rare of those tangible bodies which are properly compact and have no hollows, and that it contained the least amount of Matter for its dimensions. Then we exactly noted the weight of the Spirit and Phial together. Afterwards we took a Bladder, which might contain about two pints. We squeezed all the air out of it, as far as was possible, so that the sides of the Bladder met. We first rubbed the Bladder gently with oil to make it more air-tight; the oil closing up any pores that there might be. We then put the mouth of the Phial into that of the Bladder, and tied it tightly with a slightly waxed string, to make the binding surer and closer. Then lastly we placed the Phial over some hot coals in a brasier. After a while the steam or breath in the spirits of wine expanded by the Heat was turned into vapour, and gradually swelled out the Bladder, and stretched the whole of it on every side like a sail. After this was done, we forthwith removed the glass from the fire, and placed it on a carpet (for fear of its cracking with the cold), and directly made a hole in the top of the Bladder, for fear lest the vapour, on cessation of the Heat, should return into a liquid state and confuse the calculations. Then we took away the Bladder itself, and again weighed the remaining spirits of wine. Thence we calculated how much had been consumed in steam or vapour; and on comparison between the space it occupied while it was spirits of wine in the Phial, and which it occupied after it had become vaporous in the Bladder, we so got at the ratios; from which it was quite clear that that body after its change had expanded into a bulk one hundred times greater than it had occupied before.

Similarly; let the Nature under inquiry be Heat or Cold: that is, in such a slight degree as not to be perceptible to the senses. These are brought under cognisance of the senses by means of the Thermometer we have above described. For Heat and Cold are not actually perceived by the touch: but Heat expands, Cold contracts the air. Nor again is that expansion and contraction of air perceptible to the sight: but expanded air depresses, contracted raises, the water; and then finally it comes under cognisance of vision, and not before, nor otherwise.

Similarly; let the Nature under inquiry be the Combination of Bodies; viz. what watery, what oily, what spirituous, what ashy, salt, and other components they possess: or to take a case, what butter, cheese, whey, and the like, there is in milk. These things are brought under the cognisance of the senses by artificial and skilful separations of tangible substances. And the Nature of the Spirit in them, though not immediately perceptible, is still detected by the various motions and efforts of tangible bodies, in the very act and process of their separation: and also by the sharpness, corrosion, and divers colours, odours, and tastes of the same bodies after separation. And in this part men have worked the subject vigorously by means of distillations and artificial separations; but with about the same success that they have had in all other experiments now used: methods of mere groping, blind ways, more industrious than intelligent: and (worst of all) without any imitation or emulation of Nature, but with the destruction (through violent heats and too vigorous powers) of all the more subtle structure, wherein are mostly placed the occult virtues and sympathies of things. Nor even does that which we have elsewhere noticed come into people's minds, or before their observation, in separations of this kind: i. e. that very many qualities are introduced into bodies, when we attack them by fire or otherwise, by the action of the fire or other substances employed in the analysis; qualities which did not previously subsist in the compound; whence come wonderful mistakes. For instance; the whole amount of steam thrown off by water under action of fire was not all steam or air in the body of the water: but is for the most part caused by the expansion of water caused by the heat of fire.

Similarly; to speak generally, all those exquisite tests of bodies, natural or artificial, by which the true are distinguished from the false, the better from the worse, ought to be referred to this head: for they bring that which was beyond the cognisance of the senses under them. They are, accordingly, to be gathered from all quarters with diligent care.

Now as to the fifth kind of objects escaping the senses, it is clear that the action of the senses takes place by Motion, and that Motion requires Time. If then the Motion of any body is so slow or so fast as to bear no proportion to the portions of time in which the action of the senses is carried on, the object is not at all perceived: as is the case with the Motion of a clock's hand, and, again, with the Motion of a musket ball. Now Motion which is too slow to be perceived, is easily and usually brought within cognisance of the senses by the sum of Motions: that which is too swift, has not yet been satisfactorily measured: and yet inquiry into Nature demands that in some cases this should be done.

The sixth kind, where the senses are hindered by the grandness of the object, can be reduced, either by putting the object at a greater distance from the senses; or by deadening its power by interposing some medium which weakens without destroying it; or by admission of a reflection, where the direct impression would be too strong—as is done with the Sun's rays in a basin.

The seventh kind is that in which the senses are so overcharged with the object, that there is no room for any other impression. This rarely occurs except in the organ of smell, and in odours; nor has it much weight with our subject. Wherefore let what we have said suffice for the reduction to sense of objects beyond the cognisance of the senses.

Sometimes, however, this reduction is not made to the senses of Man, but of some other Animal whose senses in some cases surpass those of Man: as in case of some smells, it can be made to the senses of a dog: in case of light existing latent in Air not illuminated from without, to the sense of a cat, an owl, and other animals of this kind, which see by night. For Telesio has rightly noticed that in Air itself there subsists some original light, slight indeed and subtle, and such as for the most part is of no use for the eyes of Men, and of most

Animals: because those Animals, to whose senses light of this kind is adapted, see by night; and it is less credible that this sight should arise either without light, or by means of internal light.

And this must be specially noted: that we are in this place treating of the *short-comings* of the senses, and their remedies. For the *errors* of the senses are to be referred to the investigations peculiar to the senses and sensible objects: with the exception of that great error of the senses, viz. their establishing the limits of things according to their relation to man, and not to the universe: an error which is only corrected by reason and universal Philosophy.

41. Eighteenth among Prerogative Instances we will place *Instances of the Way;* which we also call *Itinerant* or *Jointed Instances.* They are such as indicate the gradually continued Motions of Nature. Now this kind of Instances rather escape observation than the senses. For the want of attention of mankind to this subject is wonderful. Men contemplate Nature in a desultory fashion, and at periodic intervals, and after that bodies are finished and complete, and not in the course of their making. But if any one wished to explore and try the ability and industry of any Artist, he would wish to inspect not only the rude materials of the Art, and then his complete works; but rather to be present while the Artist is working and carrying on his work. And something similar ought to be done with Nature. For example: if any one inquires about the vegetation of plants, he must watch from the first sowing the

seed, (which can easily be done, by pulling up, every day or so, seeds which have been in the ground two, three, four days, and so on, and by examining them carefully,) how and when seed begins to swell, and be filled (as it were) with spirit; then how it breaks its skin, throws out fibres, raising itself a little the while, unless the soil be particularly stiff; how it also sends out these fibres, some as roots downwards, others for the stalk, upwards, sometimes how they creep on sideways, if they find the ground open and more yielding that way, and many other like phenomena. So too one ought to act in watching the hatching of eggs; in which the process of animation and organization can be readily perceived, and what, and which parts are produced by the yolk, and what by the white, &c. Similarly, with the production of Animals from putrefaction: for it would be inhuman to make these inquiries upon perfect beasts, by cutting the Fœtus out of the womb; except perhaps in the case of abortions, of animals taking in hunting, and the like.

We must, then, keep strict vigils over Nature, as on one more readily visible by night than by day. For these contemplations may be counted as night-watches, from the smallness and continual burning of our light.

The same thing must also be attempted with inanimate objects: a course we have ourselves pursued in inquiry into the expansion of liquids by fire. For Water expands in one way, Wine in another, Vinegar and Verjuice in others; still more different are

Milk, Oil, &c. This was easily perceptible by their ebullition over a gentle fire, and in a glass vessel, in which every thing could be perceived clearly. But we merely touch briefly on these points, as we intend to discourse more at length and more exactly on them, when we have reached the discovery of the *Latent Process* of things. For it must always be remembered, that in this place we are not treating of things themselves, but are merely bringing forward examples.

42. Nineteenth among Prerogative Instances we will place *Supplementary Instances*, or *Instances of Substitution;* which we also term *Instances of Refuge*. These are such as supply information, when the senses fail entirely; and so we take *refuge* in them when proper instances are not to be had. Such substitution is of two kinds: either by Degrees or by Analogies. For example: no medium has been discovered which entirely hinders the operation of the Magnet in attracting Iron: Gold does not do it when interposed, nor Silver, Stone, Glass, Wood, Water, Oil, Cloth or fibrous Bodies, Air, Flame, nor any other. And yet by exact testing there may perchance be discovered some medium which deadens the Magnetic virtue more than any thing else does, comparatively and in a certain degree; as, for example, if the Magnet did not attract Iron through the great density of Gold, as much as it would through an equal distance of Air; or through as great a thickness of ignited as of cold Silver, and so on. For we have made no experiment on this; but it is

enough to be proposed as an example. Similarly; we find no body on the earth which is not susceptible of Heat when put near fire. But Air heats much more rapidly than stone. And these are cases of *Substitution* by Degrees.

Substitution by Analogous cases is useful indeed, but less sure; and therefore must be employed with some judgment. It takes place when that which is beyond the senses is brought under their cognisance, not by the perceptible operations of a body not itself perceptible, but by the contemplation of some cognate perceptible body. E. g. suppose inquiry be made as to the combination of Spirits, which are invisible bodies: there seems to be a kind of relationship between bodies, and that which nourishes and supports them. Now the fuel of flame seems to be oil and fat things: of air, water, and watery substances; for flames are multiplied by the exhalation of oil, and air by the vapours of water. And so we must regard the combination of oil and water, which manifests itself to the senses; since the combination of air and flame escapes the senses. But oil and water, which by themselves, if put together or stirred, combine very imperfectly, combine accurately and delicately in herbs, blood, and the parts of animals. And so something of the same kind might take place with the combination of flame and air in spirituous substances: things which by being simply put together combine but badly; but which seem to be duly combined in the spirits of plants and animals; especially as all animate spirits feed upon both kinds of humidity (the aqueous and the fat) as their proper nourishment.

Similarly; if inquiry be made only as to their Composition, not as to their more perfect combination; viz. whether they readily enter into each other or not; or rather (for example) whether there are any winds and exhalations, or other spiritual bodies, which do not combine with common air, but only adhere to it and float in it in globules and drops, and are broken and diminished by air rather than received and incorporated into it: this cannot be sensibly perceived in common air and other spirits by reason of the subtilty of their bodies; yet a kind of image of the thing, and of how it is done, can be conceived in such liquids as Quicksilver, Oil, Water; and even in Air and its parts, when it is dissipated and ascends through the water in small particles; and also in thick smokes; and lastly in dust raised and remaining in the air; in all of which no incorporation takes place. And the above representation is not bad on this subject, if this point be first carefully inquired into—viz. whether there can be the same difference in kind between spiritual as there is found to be between liquid bodies: for if this be so, these likenesses may be conveniently substituted by analogy.

And although in speaking of these *Supplementary Instances* we have said that information is to be drawn from them (by way of *Refuge*) when proper instances are wanting; yet we nevertheless would have it understood that they are also of great use, even when proper instances are to be had; for, taken with them, they confirm our information. But we will speak of these points more exactly, when our discourse shall in due order have reached the *Helps of Induction.*

43. Twentieth among Prerogative Instances we will place *Probing Instances:* which we also term *Twitching Instances,* (for a different reason.) For we term them *Twitching,* because they twitch the Intellect; *Probing,* because they probe Nature: wherefore we sometimes name them *Instances of Democritus.* These are such as admonish the Intellect concerning the admirable and exquisite subtilty of Nature, so as to rouse and awaken it to attention, observation, and due inquiry. For example: into how many letters or lines a few drops of ink may be extended; to what a length of gilt wire a piece of silver merely gilt on its surface can be drawn out; that such small vermin as you find in the skin have in themselves a spirit, and a figure distinct from their parts; that a very little saffron tinges even a cask of water; that a very little musk or aromatic scent imbues with its odour a far greater content of air; that a very great cloud of smoke is raised by a little incense; that the very accurate differences of sounds, such as articulate words, are carried in every direction through the air, and penetrate through chinks and pores even of wood or water (though they are much weakened thereby), and are also reflected, and that with such distinctness and speed; that light and colour pass to a great distance and very rapidly through the solid

bodies of glass, and water, and with so great and exquisite a variety of images, and are refracted and reflected; that the Magnet attracts through every kind of body, even the most compact: but (more wonderful still) that in all these cases the action of one is not much hindered by that of another in an indifferent medium like Air:—i. e. that in the same time there are transmitted through the Air such a number of images of things visible; such a number of impulses of articulated words; so many separate odours, as of violet, rose, &c.; Heat too and Cold; magnetic influences;—all of them, I say, together and none hindering other; just as if they each had their own ways and passages, and none touched or ran against any of the others.

We are wont, however, to subjoin for use to these *Probing Instances*, others which we term *Limits of the Probe*. Thus, in the cases given above, one action does not disturb or hinder another of a different kind; but if there be two of the same kind, one subdues and extinguishes the other: as, for example, sunlight, that of a glowworm; the report of a cannon, the voice; a strong smell, a more delicate one; a fiercer Heat, a gentler one; plates of Iron placed between the Magnet and another piece of iron, the attraction of the Magnet. But the proper place of speaking of these, too, will be among the *Helps of Induction*.

44. We have now spoken of the Instances which assist the senses: and which are of the greatest use for information. For information begins with the senses. But our whole work ends in Practice; and

as Information is the beginning, so Practice is the end of our subject. And so there will follow instances of chief use for operation. These are of two kinds, and are seven in number. We call them all by the general name of *Practical Instances*. In Practice there are two defects, and two kinds of excellent instances. For either Practice deceives, or it imposes too much labour. It deceives chiefly (and most of all after diligent inquiry into Natures) on account of error in limitation and mensuration of the strength and action of bodies. The strength and action of bodies are circumscribed and measured, either by Space, or by Time, or by Union of Quantity, or by Predominance of Virtue: and unless these four be rightly and diligently weighed, there will perhaps be Sciences fair in theory, but they will be ineffectual in Practice. We call the four Instances, which correspond to these, by the one title of *Mathematical Instances*, and *Instances of Measure*.

Now Practice becomes laborious, either because of the admixture of useless things; or because of the multiplying of instruments; or because of the mass of matter and of bodies which may happen to be requisite for any work. And so those instances ought to be valued which either direct Practice to those points which are of the greatest importance to man; or which lessen the number of instruments used; or of matter or furniture to be acted on. The three Instances which bear on this object we call by the one title of *Propitious* or *Benevolent Instances*. And so we will now speak separately of each of these seven

Instances; and with them conclude this part of our work which treats of Prerogative or Illustrious Instances.

41. Twenty-first among Prerogative Instances we will place *Instances of the Rule or Measuring-rod;* which we also term Instances of *Carrying through*, or of the "*Non ultra.*" For the virtues and motions of things act and are completed in spaces, not indefinite or fortuitous, but finite and certain; and it is of the greatest importance to Practice that these should be taken and noted in each Nature inquired into; not only to avoid error, but to render Practice more extensive and powerful. For it is sometimes possible to extend these virtues and (as it were) to lessen their distances; as in the case of Optical Instruments.

And most virtues act and affect things only by manifest touch; as is the case in impact of bodies; where the one does not remove the other, unless the impinging body touch the other. So too external applications in Medicine, as Ointments and Plasters, do not exercise their strength, except by being in contact with the body. Lastly, the objects of touch and taste do not strike those senses, except when contiguous to the organs.

There are too other virtues which act at a distance, though it be a very small one; few of these have as yet been noticed, and yet they are more in number than men suspect: as (to take a familiar example) Amber and Jet attract straw; Bubbles break others in their neighbourhood; some purgative Medicines elicit humours from the inmost parts; and the like. But that Magnetic virtue, by which Iron and the Magnet, or two Magnets, draw together, operates within a certain small circle of virtue; while, on the other hand, if there is any Magnetic virtue, which emanates from the earth itself (a little below the surface), and affects the Needle in its Polarity, it must act at a great distance.

Again; if there is any Magnetic force which acts by consent between the earth and heavy bodies; or between the moon and the waters of the sea (as seems most credible in the spring and neap tides twice in the month); or between the starry Heavens and the Planets, by which they are called forth and raised to their Apogees: all these must act at a very great distance. There are found, too, certain kindlings or lightings of flame which in some materials take place at very great distances; as they tell of Babylonian Naphtha. Heat, too, insinuates itself at great distances; as also does Cold: so that the bergs or masses of ice, which are broken off and float in the Northern Ocean, and are carried through the Atlantic towards the shores of Canada, are felt by the inhabitants and lower the temperature at a great distance. Odours, too, (though in these there always seems to be some corporeal emission,) act at notable distances; as is wont to happen to men sailing along the shores of Florida, and of part of Spain, where there are whole woods of lemons, oranges, and such fragrant plants; or shrubs of rosemary, marjoram, and the like. Lastly, the radiations of light, and impressions of sound act at great distances.

But all these powers, whether they act at small or great distances, act certainly at distances which are finite and known to Nature—so that there is a "*Non ultra*"—a limit; and that corresponding either to the mass or quantity of bodies, or to strength or weakness of virtues, or to favourable or unfavourable media; all which things ought to be reckoned in and noted. Farthermore, we must note the Measures of violent motions (as they call them), as of missiles, projectiles, wheels, &c., as these too have clearly their own determined limits.

There are also found some motions and virtues contrary to these which operate in contact, and not at a distance; namely, such as act at a distance, and not in contact; and again, those which act more slightly at a less distance and more strongly at a greater. Vision does not act well in contact, but requires a medium and distance: although I remember to have heard a certain credible person tell that he himself when being cured of the cataract (cured by inserting a small silver needle within the first coating of the eye, so as to remove the pellicle of cataract, and force it into a corner of the eye) most clearly saw the needle as it moved over the pupil. Still, although this may be true, it is clear that larger bodies are not well or distinctly visible, except at the vertex of the cone where the rays converge at some distance from the eye. Moreover, the eye of old persons sees better if the object be removed to a greater not to a less distance. It is certain, besides, that in missiles the impact is not so violent at a very short distance as it is a little while afterwards. These and the like things are accordingly to be noted, as concerns distance in measuring motion.

There is also another kind of Measure of motion in Space which must not be passed over; that of spherical not progressive motion; i. e. of the expansion of bodies into a greater sphere, or their contraction into a less. For in measuring this kind of motion, inquiry must be made as to how much compression or extension bodies readily and willingly admit (according to their Natures), and at what limits they begin to resist, so that at last they allow it *Non ultra;* as when an inflated bladder is squeezed it allows a certain compression of air, but if this be increased too much, the air does not suffer it, and the bladder bursts.

We have proved this by means of a more delicate experiment. We took a metal bell, somewhat light and thin, of the kind used to hold salt, and plunged it into a basin of water, so that it carried down with it to the bottom of the basin the air contained in its interior. We had first placed a little globe in the bottom of the basin, on to which the bell was to be put. The result followed, that if that ball was but little in comparison with the content of the bell, the air contracted into a less space, and was compressed without being forced out: but if the ball was too large for the air to yield readily, then the air, being impatient of too great a pressure, raised the bell on one side, and escaped in bubbles.

To prove also how much extension, no less than compression, the air will suffer, we took the following course. We took a glass egg, with a small hole at one end: we drew out the air by violent suction at the hole, and directly closed it with our finger; then we plunged the egg in water, and lastly removed our finger. The air then having been constrained by the suction, and expanded beyond its natural state, and so striving to recover and contract, (so that if the egg had not been plunged in water it would have drawn in air with a hissing sound,) now drew in a sufficient quantity of water to allow the air to recover its former volume or dimensions.

And it is certain that very rare bodies like air admit of considerable contraction, as has been said: while tangible bodies like water admit of far less compression, and much less readily. How much they admit we have investigated by means of the following experiment.

We had a leaden globe made to hold about two pints (wine measure) of a sufficient thickness for it to bear considerable force. We made a hole in it, and filled it with water; and then plugged the hole with molten lead, so that the whole was quite sound. Then we flattened the globe on two opposite sides with a heavy mallet, which forced the water to contract, as the sphere is the figure of the greatest content. Then, as the hammer failed through the resistance of the water, we used a mill or press; so that at last the water, impatient of farther pressure, exuded like a fine dew through the solid lead. Afterwards we reckoned the amount of space diminished by that compression, and concluded as to how much compression water admitted, when acted on by great violence.

But solid, dry, and more compact bodies, like stones, wood, and metals, admit of far less, and an almost imperceptible compression or extension; and free themselves by breaking, progression, or other efforts; as is seen when wood or metals bend, when clocks are moved by springs, in missiles, hammering, and innumerable other kinds of motion. And all these things are to be noted and explored together with their Measures, in the investigation of Nature; either to a certainty, or by estimation, or by comparison, as opportunity allows.

46. Twenty-second among Prerogative Instances we will place *Instances of the Course;* which we also term *Instances of the Water;* an expression borrowed from the water-glasses of the Ancients, into which water was poured instead of sand. These measure Nature by subdivisions of Time, just as the *Instances of the Rule* by degrees of Space. For every kind of motion or natural action takes place in Time, some more rapidly, others more slowly, but, anyhow, in certain subdivisions of Time known to Nature. Even those actions which seem to act suddenly and in

the twinkling of an eye (as the phrase runs) are found to admit of greater or less rapidity in Time.

In the first place, then, we see that the revolutions of the Heavenly Bodies take place in regular Times: so too the ebb and flow of the sea. The tendency of heavy bodies towards the ground and of light ones towards the heavens takes place in definite Times, according to the Nature of the body moving and of the medium. The sailing of ships, the movements of animals, the projection of missiles, all occur in Times whose sums can be computed. As to Heat, one sees boys in winter wash their hands in flame without being burnt; and jugglers can by quick and regular motion turn vessels full of wine or water mouth downwards, and again replace them without spilling a drop; and many such things. The compression, too, or expansion, and eruption of bodies take place some more quickly, others more slowly, according to the Nature of the body and of the motion, but all in definite intervals of Time. In the firing of several guns at once, audible sometimes for thirty miles, the sound is sooner perceived by those who are nearer the place of its origin than by those who are farther off. In vision, too, (whose action is most rapid of all,) it is clear that a definite Time is required for its transmission; as is proved by those objects which from the velocity of their motion are invisible—as, for example, a musket-shot. For the flight of the ball is too swift to allow an impression of its figure to be conveyed to the sight.

And this, with similar things, has sometimes begotten in us a monstrous doubt—as to whether the face of the clear starry sky is visible to us instantaneously, or rather a little later; and whether there is not (as regards vision of celestial objects) as much a true and an apparent Time, as there is a true and an apparent position, as is noted by Astronomers in Parallaxes. So incredible did it appear that the figures or rays of Heavenly Bodies could be suddenly conveyed to the sight through so immense spaces of miles; they must, it seemed, require some definite Time for transmission. But this doubt (as to some considerable interval of Time between true and apparent Time) afterwards was entirely set at rest; when we considered that infinite loss and diminution of quantity, as regards the real body and the apparent figure of a star, which is caused by distance; especially as we at the same time noticed from what a distance (sixty miles at least) bodies, and those only white, (and not bright,) are visible instantaneously; for it cannot be doubted that the light of the Heavenly Bodies far exceeds not only the vivid appearance of white, but also the light of all flame known to us, in point of vigour of radiation. And the immense velocity of the bodies themselves, perceptible in their diurnal motions (which has so astounded even thinking men, that they have preferred to believe that the earth moves), renders the Motion of Radiation from them (marvellous though it be in its swiftness) more credible.

And this has weighed most of all with us—that if there were any appreciable interval of Time between the true and the apparent sight, it would follow that their appearances would be often intercepted and confused by the rise of clouds and similar disturbances of the medium. Let, then, this be enough upon the simple Measures of Time.

But the relative Measure of motion and actions must be sought for with much more care than even the simple Measure; for it is of singular use, and of many applications. And we see that the flame of firearms is seen before their sound is heard; although it is necessary that the ball should strike the air sooner than the flame does, which issues after it: this arises from the fact that light moves with far greater velocity than sound. We see, too, that visible images are received by the sight more rapidly than they are dismissed; whence it follows, that the strings of violins when touched seem double or triple, because a new image is received before the previous one has been got rid of; just too as rings when they spin seem to be spherical; and a burning torch, carried swiftly by night, has a tail. From this foundation, too, of the inequality of motions (as to velocity) Galileo reasoned out an explanation of the cause of tides, from the swifter rotation of the earth than of the water; whence the water would first gather, and then in turn sink, as is shewn when one moves a vessel of water rapidly. This, however, he has imagined on data which cannot be granted (viz. the motion of the earth), and under wrong information as to the Ocean's ebbing and flowing every six hours.

But there is an excellent example of our topic (the comparative Measures of motion)—and that not only of the thing itself, but of its singular use, of which we spoke just now,—in mines filled with gunpowder; whereby vast masses of earth, buildings, &c. are overturned, and thrown up into the air, by a small quantity of powder. The cause of this is certainly that the expansive motion of the powder, the agent, is very far swifter than the motion of gravity which had to resist it; so that the first motion is over before the antagonist motion has begun; so that at first there is a kind of absence of resistance. Hence, too, it comes that in every sort of projectile a blow sharp and sudden rather than strong is most powerful in causing motion. Nor indeed could so small a quantity of Animal Spirit in animals, (especially in bodies as vast as the whale or the elephant,) turn and rule so great a corporeal mass, save by reason of the velocity of motion of the Spirit, and the slowness of the bodily mass in resisting it.

In short, this is one of the chief foundations of magical experiments, of which we will shortly speak;—where a small mass of matter overcomes and regulates a much larger mass; that is, if the motion of the one can, through its rapidity, anticipate the other before it is prepared to act.

Lastly; this priority and posteriority ought to be observed in every natural action. Thus in an infusion of rhubarb there is first elicited a purgative and then an astringent power; so too we have noticed something of the same kind when distilling violets in vinegar, first we get the sweet and delicate scent from the flower, and afterwards the more earthy part which pollutes the scent. And so if violets be steeped for a whole day a much fainter perfume is extracted; if steeped for a quarter of an hour only, and then taken out, and (because the scented spirit in violets is but small) other and fresh violets be steeped every quarter of an hour, and this be repeated six times, then the infusion is so much strengthened, that although the violets have not remained therein (the whole of them, how often soever renewed) for more than an hour and a half, still there remains a most pleasant scent which will last for a twelvemonth, and is not inferior to the violet itself. It must, however, be noticed that the perfume does not acquire its full strength till a month after the infusion. In the distillation of bruised aromatic plants in spirits of wine, it is well known that there first rises an aqueous and useless scum, then water containing a larger proportion of the spirits of wine, and lastly water containing a larger proportion of aroma. And very many things of this sort worth noticing are discovered in distilling. But let these suffice as examples.

47. Twenty-third among Prerogative Instances we will place *Instances of Quantity*, which we also

term *Doses of Nature* (borrowing a term from Medicine). They are such as measure virtues by the *quantity* of bodies, and point out the effect of the *quantity of body* relatively to the *measure of virtue.* And first, there are some virtues which do not subsist save in *Cosmical Quantity;* i. e. in such *Quantity* as has relation to the conformation and fabric of the Universe. For the earth stands, and its parts fall. The water in seas ebbs and flows; not at all so in rivers, except by the sea's running up. Then, too, almost all particular virtues act according to the greater or less *Quantity* of the body. A large body of water does not readily become putrid, a small body does quickly. New wine and beer become ripe and drinkable far sooner in small skins than in large casks. If a herb is put into a large *Quantity* of water there results infusion rather than impregnation; if in a small *Quantity,* the reverse. So, too, a bath and a light sprinkling have different effects upon the human body. Light dew, too, in the air never falls, but is dissipated and incorporated in the air. And one can see when one breathes upon a jewel, that that little *Quantity* of moisture is forthwith dissolved like a small cloud scattered before the wind. A piece of a Magnet, too, does not attract so much iron as a whole Magnet does. There are also virtues in which smallness of *Quantity* is more powerful: as, for example, in boring, a sharp point penetrates more quickly than a blunt one; and the diamond, when pointed, cuts glass; and so on.

But one must not delay here with what is indefinite, but must also inquire into the ratio borne by *Quantity of bodies* towards the measure of Virtue. For it would be an easy thing to believe that the *Quantity* bears ratio of equality to the Virtue; as if a leaden ball weighing an ounce were to fall so far in a certain time, a ball weighing two ounces ought to fall twice as fast, which is entirely false; nor do the same ratios hold in every kind of Virtue, but very different ones. And so these Measurements are to be sought for from things themselves, and not from probability or conjectures.

Lastly; in all investigation into Nature we must note *how much* body is required for a given effect (just as one would do with a dose of medicine): and cautions must be added as to the *too much* and the *too little.*

48. Twenty-fourth among Prerogative Instances we will place *Instances of the Struggle*, which we also term *Instances of Predominance.* These point out the Predominance or Yielding of Virtues one with another; and tell us which of them is the stronger and victorious; which the weaker and vanquished. For the Motions and efforts of bodies are compounded, decomposed, and complex, as much as the bodies themselves are. We will accordingly first set forth the chief kinds of Motions or active Virtues; in order that their comparison in point of strength, and thence the setting forth and marking out of the *Instances of the Struggle* and *Predominance*, may be more evident.

i. Let the first Motion be that of the *Resistance* (Antitypia) of matter which subsists in each of its particles: by reason of which it will not be annihilated: so that no burning, weight, or depression, no violence, no age or continuance of time, in fine, can reduce to nothing any even the smallest portion of matter, and prevent it from being something and occupying some space, and from freeing itself (to whatever straits it is put) by changing its form or place; or, (if it cannot do this) from subsisting as it is; nor can it ever result that it should become nothing, or be nowhere. This Motion Philosophers (who almost always name and define things rather by their effects and inconveniences, than by their interior causes) either denote by the Axiom that "Two bodies cannot be in one place;"—or call it a Motion "to prevent the interpenetration of dimensions." Nor is it worth while to give examples of this Motion; for it subsists in all bodies.

ii. Let the second Motion be that which we call Motion of *Connexion*, by which bodies do not allow themselves to be separated at any point from some other body, as though they rejoiced in mutual connection and contact. This kind Philosophers term Motion "to prevent Vacuum:" as when water is attracted upwards by Suction, or by a Syringe; or the flesh by Cupping: or when water stands without escaping from perforated Jars, unless the mouth of the Jar is opened to admit Air: and multitudes of this kind.

iii. Let the third be that of *Liberty* (as we call it):

by which bodies endeavour to free themselves from unnatural pressure or tension, and to return into the dimensions which suit their body. Of this Motion, too, there are innumerable examples: as (of escape from pressure) water, in swimming; air, in flying; water, in rowing; air, in the undulations of winds; the springs of clocks. And the Motion of compressed air is shewn rather prettily in children's popguns, which they make by scooping out a piece of elder or such wood, and stuff in a piece of some succulent root or other substance, at both ends; then they force the piece of root, or other such pellet to the other end by means of a ramrod; and so the pellet at that other end is shot out with a noise, and that too before it is touched by the nearer piece of root or pellet, or by the ramrod. As to liberation from tension this Motion shews itself in the Air which remains in glass-eggs after they have been exhausted, in strings, leather, cloth, which leap back after tension, unless it has lasted long enough to be fixed, &c. And this kind Philosophers indicate under the name of Motion from "the Form of Element:" unskilfully enough, as this Motion pertains not only to air, water, or flame, but to all different solids, as wood, iron, lead, cloth, parchment, &c. in which each body has a measure of its own dimensions, and is with difficulty stretched into any other appreciable space. But since this Motion of *Liberty* is the most obvious of all, and one which occurs in an infinite number of cases, it would be well to distinguish it well and clearly. For some very carelessly confound this

Motion with the pair of *Resistance* and *Connexion*, i. e. the liberation from pressure with the Motion of *Resistance*, and that from tension, with that of *Connexion*: just as if bodies, when compressed, yielded or expanded to prevent an *Interpenetration of Dimensions*; recoiled and contracted, when stretched, to avoid a *Vacuum*. But even if air, when compressed, were to contract to the density of water, or wood to that of stone; there would be no need of *Interpenetration of Dimensions*, and yet the compression would be far greater than they actually admit. Similarly, if water were to expand to the rarity of air, or stone to that of wood; there would be no need of a *Vacuum*: and yet the expansion would be far greater than they at all admit. And so the matter is not brought to *Interpenetration of Dimensions*, and *Vacuum*, unless it be in extreme cases of condensation and rarefaction: whilst the Motion we are discussing stops and takes place far within those cases; and it is nothing but the desire of bodies to preserve their specific densities (or, if it be preferred, their Forms,) and not to recede suddenly from them, or allow of alteration, save in gentle ways and of their own accord. It is far more necessary for men to be told (for it has important results) that Violent Motion, which we term *Mechanical*, but which Democritus, who in explaining his prime Motions must be ranked even below inferior Philosophers, termed Motion of the *Blow* (πληγῆς), is nothing but the Motion of *Liberty*, i. e. from compression to relaxation. For in all simple impulsion, or flight through air, there is no displacing or Motion in space, before the parts of the body are unnaturally acted on, and compressed by the impelling power. And then each part in due succession pushing on other, the whole body is borne along;—and that not only with a progressive but with a rotatory Motion; so that the parts may thus free themselves, or, at any rate, the more readily endure the pressure. And thus much on this sort of Motion.

iv. Let the fourth be that to which we have given the name of Motion of *Matter* (ὕλης). It in a way corresponds to that of *Liberty*, of which we have been speaking. For in Motion of *Liberty* bodies abhor, reject, avoid any new dimension, or new sphere, or new expansion or contraction, (the terms mean the same thing,) and endeavour with all their might to recoil and to recover their original density. On the other hand, in this Motion of *Matter*, bodies desire a new sphere or dimension; and aspire after it readily and quickly, and sometimes most violently, (as in the case of gunpowder.) The most potent, or at least the most common (though certainly not the only) instruments of this kind of Motion, are Heat and Cold. For example: air, if expanded by tension, (as when exhausted from a glass-egg,) labours under a great desire of restoring itself. But on application of Heat, it, on the contrary, desires expansion, and longs for a new sphere, and passes or migrates gladly into it, as though into a new Form, as men call it. Nor after some expansion does it want to return, unless invited to do so by application of Cold: and this is not a return, but a second transmutation. Similarly water, if confined by compression, resists, and wishes to become what it was, i. e. more expanded. But if there intervenes intense and continued Cold, it changes itself voluntarily and gladly into the condensed form of ice: and if the Cold be steadily continued, without interruption from warmth, (as is the case in grottos and deep caves,) it is turned into crystal, or some such matter, and never resumes its shape.

v. Let the fifth be Motion of *Continuity;* by this we mean not simple and primary *Continuity* of one body with any other (for that is the Motion of *Connexion*), but of the *Continuity* of a body in itself. For it is most certain that all bodies dread a solution of *Continuity*, some more, some less, but all to a certain extent. For as in hard bodies (like steel or glass) there is a very powerful and strong resistance against discontinuation; so even in liquids, where this kind of Motion seems to cease, or at any rate to grow faint, it is not found to be altogether wanting, but clearly exists in them in its lowest degree, and shews itself in very many experiments; as in bubbles, in the round shape of drops, in the fine threads of eaves-droppings, and in the cohesion of glutinous substances, &c. Most of all does it shew itself if one attempts to carry this discontinuation to the smaller particles. For in mortars, after a substance has been bruised to a certain degree, the pestle will not act any longer: water will not enter very small chinks: nay, air itself (notwithstanding its subtilty of body) does not directly pass through the pores of somewhat solid vases, but takes a long time to get in.

vi. Let the sixth be that we term Motion towards *Gain*, or of *Need*: It is that by which bodies, when placed among others which are quite heterogeneous and (as it were) hostile, if perchance they get means or opportunity of avoiding them, and of attaching themselves to something more cognate (even though those cognate substances are such as have no close sympathy with them), yet they straightway embrace them, and prefer them as better, and seem to count it as *gain* (whence we chose the name), as if they were in need of such bodies. For example; gold and other metals in leaf do not like the surrounding air. And so, if they meet with any tangible and solid body, (like the finger, paper, or anything else,) they directly cling to it, and are not easily torn from it. Paper, too, and cloth, and things of that kind, do not get on well with the air which is inserted into and mingled with their pores. And so they gladly suck in water or other liquid, and drive out the air. Sugar, too, or sponge dipped in water or wine, although part of it stands up out of the wine or water, yet little by little it gradually attracts the liquid to the top.

Whence a most excellent rule is derived for the opening and dissolution of bodies. For (not to mention corrosives and strong waters which make a way for themselves) if there can be found a body which is more adapted, sympathetic, and friendly to another solid body than that body is with which it is by a kind of necessity connected, the body directly opens and relaxes itself, and takes in that other body, to the exclusion and removal of the first. Nor does this Motion towards *Gain* act or use influence only to the touch. For electric agency (about which Gilbert, and others after him, have set afloat such stories) is nothing but the appetition of a body excited by gentle friction, which does not well endure the air, but would rather have some other tangible substance, if such be found in its neighbourhood.

vii. Let the seventh be that we term Motion of *Greater Congregation;* by which bodies are carried to masses of a similar Nature: heavy ones towards the Earth, light ones towards the Heavens. This Motion Philosophers have honoured with the title of Natural, shallowly enough; because, forsooth, it is produced by nothing externally visible (and so they thought it innate and implanted in things themselves), or perhaps because it never ceases: nor is this marvellous, as the Heavens and the Earth are ever at hand; while on the other hand the causes and origins of most other kinds of Motion are sometimes wanting and sometimes present. And so they laid it down that this kind of Motion, because it never fails, but is one which occurs directly when others fail, is perpetual and natural; the other kinds acquired. Whereas in reality this Motion is weak and slow, since it yields (unless the mass of the body be very large) to other Motions when they act upon it. And though this kind of Motion has so filled men's minds that it has nearly hidden all other kinds from sight; yet men know very little about it, and make plenty of mistakes respecting it.

viii. Let the eighth be the Motion of *Lesser Congregation;* by which the homogeneous parts in any body separate themselves from the heterogeneous, and collect together; by which, too, whole bodies, whose substance is similar, unite and cling together, and are sometimes congregated, attracted, and come together from some distance: as when the cream in milk after a time gathers on the surface, or lees and dregs in wine settle. And this is not caused by Motion of gravity and levity only, whereby some parts would rise to the surface and others sink to the bottom; but (much more) it arises from the desire of homogeneous bodies to collect and unite. This Motion differs from that of *Need* in two ways. First, because in that of *Need* there is the greater stimulus of a malignant and contrary Nature: while in this Motion (if only there be no hindrance or restraint) the parts are united through friendship, even though there be no foreign Nature present to arouse contention. Secondly, because the union is closer, and, as it were, more select. For in that of *Need*, so long as the unfriendly body is avoided, bodies which are not closely cognate come together: while in this, substances unite which are bound together by a relationship of kindred; and are almost fused into one mass. And this Motion exists in all compounded bodies; and would be readily discernible in each were it not bound and curbed by other appetitions and necessities of bodies which disturb that union.

This kind of Motion is restrained for the most part in three ways: (1) by torpor of bodies; (2) by the curb of the dominant body; (3) by external Motion.

(1) As to the first of these, it is certain that there is in tangible bodies a kind of sluggishness, more or less, and a hatred of Motion in space; so that, unless excited, they would rather be contented with such condition as they are in, than move to any better. And this torpor is shaken off by means of three things; (*a*) by Heat; (*b*) by the powerful virtue of some cognate body; (*c*) by swift and powerful Motion. (*a*) Hence it comes that Heat is pronounced to be *that which separates the heterogeneous and collects the homogeneous.* This definition of the Peripatetics Gilbert very properly laughed at; saying, that it was just as if any one were to say (as a definition), that Man is that which sows wheat and plants vineyards: for it is a definition by effects, and those, too, only particular ones. But that definition is even more faulty still; because those effects (such as they are) do not result from a Property, but only from an Accident of Heat (for Cold has the same power, as we will shew hereafter),—i. e. from the desire of union felt by Homogeneous parts, with only the help of Heat in shaking off the torpor which had previously restrained that desire. (*b*) As to the help from virtue infused by a cognate body: this is very

clear in a magnet armed, which rouses in iron the virtue of detaining iron through similitude of substance, after that the torpor has been shaken off by the virtue of the magnet. (*c*) As to the help from Motion: this is seen in wooden arrows with a wooden head; for these penetrate more deeply into other wood than they would do if headed with iron, thanks to similitude of substance; the torpor of wood having been shaken off by swift Motion:—of these two experiments we have also spoken in our Aphorism on *Clandestine Instances.*

(2) That restraint of Motion of *Lesser Congregation*, which arises from the curb of a dominant body, is seen in solution of blood and urine by means of Cold. For as long as those bodies are full of the active spirit which, as master of the whole, arranges and restrains each of their parts of whatever kind, so long the different parts do not gather together, because of the curb on them; but after that spirit has evaporated, or been choked by the Cold, then the parts freed from the curb gather according to their natural desire. And therefore it arises that all bodies which contain a pungent spirit (as salts and the like) endure and are not dissolved, because of the permanent and durable curb of the dominant and imperious spirit.

(3) The restraint of the Motion of *Lesser Congregation* which results from external Motion is chiefly seen in that agitation of bodies by which putrefaction is prevented. For all putrefaction depends on the *Congregation* of homogeneous parts; whence

little by little the first Form (as they call it) is corrupted, and a new one generated. For the dissolution of the old Form precedes the putrefaction, which paves the way to the generation of a new Form: and that is itself union of homogeneous parts. Now if this is not hindered, the dissolution is simple; but if various obstacles occur, putrefaction (the rudiments of a new generation) follows. But if (which is our present point) there is frequent agitation from external Motion: then that Motion towards union (which is delicate and soft, and needs to be free from external influences) is disturbed and ceases: as we see to be the case in very many things:—as the daily agitation or flowing of water prevents its putrefaction; winds prevent pestilence in the air; grain in granaries, if turned and shaken, remains pure; in fine, all things which are agitated externally do not readily putrify internally.

We must not omit that union of parts of bodies, whence for the most part there follows hardening and drying. For after that the spirit, or moisture turned into spirit, has evaporated in any porous body like wood, bone, parchment, &c., then the thicker parts contract and come together with greater effort; whence follows hardening or drying; which we think results not so much because of the Motion of *Connexion* ("ne detur Vacuum") as because of that Motion of friendship and union.

As to bodies which come together from a distance, such cases are uncommon and rare: and yet they are more common than is generally observed. Illustrations of this are bubbles which break each other; medicines which draw out humours from similitude of substance; strings on different violins which sound in unison; and the like. We think that this Motion flourishes in the spirits of animals also, though it is quite unknown. It certainly is conspicuous in the Magnet and magnetised iron. But when we speak of the Motions of the Magnet distinctions are to be drawn. For there are four virtues or operations in the Magnet, which ought to be separated, not confounded; although the admiration and wonder of men has mixed them up together. 1. The Motion of Attraction of Magnet to Magnet, or of iron to Magnet, or magnetised iron to iron. 2. That of its polarity towards the North and South, and at the same time of its Variation. 3. That of its penetrating through gold, glass, stone, all things. 4. That of the communication of its virtue from the Loadstone to iron, and from iron to iron, without communication of substance. But in this place we speak only of the first kind of virtue, viz. that of its Attraction. There is also a remarkable Motion of Attraction between quicksilver and gold; so that gold attracts the quicksilver though worked up into unguents: and workmen in its vapours are accustomed to hold a bit of gold in their mouths, to collect the exhalations, which would otherwise work into their heads and bones;—and the piece of gold after a while turns white. So much upon the Motion of *Lesser Congregation.*

ix. Let the ninth be *Magnetic* Motion, which, though the same in kind with that of *Lesser Congregation*, yet if it operates at great distances, and on great masses of things, deserves a separate inquiry; especially if it neither begins with contact, as most do, nor carries action on to contact as all congregative Motions do; but only raises bodies, or makes them swell, and does no more. For if the Moon raises the water; or makes moist substances swell; or if the Starry Heavens attract the Planets towards their apogees; or the Sun confines Venus and Mercury to within a certain distance from himself; these Motions seem not to be fairly placed either under that of *Greater* or *Lesser Congregation*, but to be as it were of intermediate and imperfect *Congregation*, and so to form properly a class by themselves.

x. Let the tenth be Motion of *Avoidance;* that which is contrary to the Motion of *Lesser Congregation;* by which bodies, from an antipathy, avoid and reject what is unfriendly to themselves, and separate themselves from it, and refuse to mingle with it. For although this Motion may seem in some cases to be only accidental, or by consequence, when compared with that of *Lesser Congregation*, because homogeneous parts cannot combine, unless the heterogeneous are excluded and removed; yet this Motion is to be put by itself and made into a distinct class, because in many cases the appetite of *Avoidance* is perceived to be more important than that of coition.

Now this kind of Motion is peculiarly remarkable in the excrements of animals; and not less so in objects hateful to certain senses, especially smell and taste. For a fœtid smell is rejected by the nose, so as to produce a sympathetic Motion of expulsion in the orifice of the stomach; a bitter and rough taste is so rejected by the palate or throat as to produce a sympathetic shaking and shrinking of the head. This Motion is also found in other cases. It is seen in some antagonisms (Antiperistasis); as in the mid-region of air, whose cold seems to be a rejection of cold Nature from the limits of the Heavens; such as, too, those great heats and combustions, which are found in subterraneous places, and which seem to be rejections of the Nature of Heat from the interior of the earth. For Heat and Cold, if in a less quantity, destroy one another; if in greater masses, and (as one might say) in equal armies, they fight, and in turn dislodge and eject one another. They also say, that cinnamon and sweet-smelling things, placed near privies and foul places, retain their scent the longer, because it refuses to go out and mix with the bad smells. Certainly, quicksilver, which would otherwise reunite into a complete mass, is hindered by spittle, lard, turpentine, or the like, from doing so; because of its want of sympathy with such bodies; so that it draws back when surrounded by such, and so its *Avoidance* of these intervening bodies is stronger than its desire to unite with its similar parts; this is what is termed "the mortification of quicksilver."

The reason, too, why oil will not mingle with water is not so much their difference in gravity as their want of sympathy: as one may see in spirits of wine, which, though lighter than oil, mix readily with water. And most of all is the Motion of *Avoidance* remarkable in saltpetre and similar crude bodies, which hate flame—as in gunpowder, quicksilver, and even gold. The *Avoidance* of the one pole of a magnet by iron is rightly noticed by Gilbert as no proper *Avoidance*, but coition to a more suitable position.

xi. Let the eleventh be Motion of *Assimilation*, or of *Multiplication of self*, or of *Simple Generation*. By *Simple Generation* we mean not that of whole bodies, as in plants or animals, but of similar bodies. By this kind of Motion bodies turn others that are similar and akin to themselves, or at any rate well-disposed and prepared, into their own substance and Nature: like flame, which multiplies itself over vapours and oily substances, and generates fresh flame: air, which multiplies itself over water and watery bodies, and generates fresh air: the spirit of vegetables and animals, which multiplies itself over the thinner particles of both watery and oily substances, which nourish it, and generate fresh spirit: the solid parts of plants and animals; leaves, flowers, flesh, bone, &c., which each assimilate some part of the juices of their nutriment, and generate a successive and ever-renewed substance. For let no one be pleased to rave with Paracelsus, who (blinded by his distillations) would have it that nutrition takes place by mere separation, and that the eye, nose, brain, liver, lie concealed under bread or food; and roots, leaves, flowers, in the juices of the soil. For just as the Artist from a rude lump of stone or wood, by rejecting what is superfluous, produces leaves, flowers, eyes, nose, hands, foot, and the like; so (he affirms) the Great First Artist within us produces each member and part out of nutriment by means of separation and rejection. But to leave such trifling, it is most certain that each part, similar or organic, in vegetables and animals, first attracts with a sort of selection, and then assimilates and converts into their own Nature those juices of their nutriment which are almost the same, or not very far different. Nor does this *Assimilation* or *Simple Generation* take place only in animate bodies; inanimate ones also partake of it; as has been said of flame and air. Farthermore, the dead spirit which is contained in every tangible animate body is always digesting and turning the thicker particles into spirit, which afterwards is exhaled; whence follows (as elsewhere we have said) diminution of weight, and drying. Nor is that accretion, which people generally distinguish from nutrition, to be rejected from *Assimilation;* as when mud grows between stones, and turns into stony matter; the scaly substance round teeth turns into a substance as hard as the teeth themselves, &c. For we are of opinion that all bodies have a desire of *Assimilation* as much as of coition with homogeneous bodies: but the one virtue is restricted as much as the other; though not in the same ways. But one ought to inquire with all diligence into those ways of restriction, and how they are to be got rid of—for this bears upon the revival of old age. Lastly, it seems to us to be worth notice, that in the nine preceding classes of Motion of which we have spoken, bodies seem only to seek the conservation of their own Nature; in this tenth class their propagation.

xii. Let the twelfth be the Motion of *Excitation*, which seems to be of the same class with that of *Assimilation*, and is sometimes promiscuously called by that name by us. For it is a diffusive, communicative, transitive, and multiplicative Motion just as that is; and they agree too in effect, for the most part, although they may differ in manner of operation and subject. For the Motion of *Assimilation* proceeds as it were with authority and power; for it orders and compels the assimilated to turn and change into the assimilating; while the Motion of *Excitation* proceeds, as it were, artfully, cunningly, and stealthily; and only invites and disposes the excited to the exciting nature. That of *Assimilation*, too, multiplies and transforms bodies and substances; there is produced more flame, air, spirit, or flesh. While in that of *Excitation* the virtues only are multiplied and pass on; and there is more Heat, more Magnetism, more Putridity. This Motion, too, is most apparent in Heat and Cold. For Heat does not diffuse itself when it heats a body, by communication of the first Heat; but only by *Excitation* of the parts of a body to that Motion, which is the form of Heat; of which we spoke in our *First Vintage of the Nature of Heat.* And so Heat is excited in stone or metal with far greater difficulty than in air, in consequence of the incapacity and unreadiness of these bodies for that Motion; so that it is probable, that there are materials in the very bowels of the earth, which quite refuse to grow hot; because they are deprived by their greater condensation of that Spirit, from which this Motion of *Excitation* for the most part begins. Similarly, the magnet gives to iron a new disposition of parts and conformable Motion; while it itself loses nothing of its virtue. Similarly, leaven, yeast, rennet, and some poisons excite and unite successive and continued Motion in dough, beer, cheese, and the human body: not so much from the strength of the exciting, as from the predisposition and ready yielding of the excited body.

xiii. Let the thirteenth be the Motion of *Impression,* which is also the same in kind with that of *Assimilation;* and is the most subtle of diffusive Motions. It seems good to us to make a distinct species of it, because of the evident difference between it and the former two. For simple Motion of *Assimilation* transforms bodies themselves; so that if you take away the prime moving power, it makes no matter with respect to what follows. For neither the first kindling into flames, nor the first conversion into air, has any thing to do with the flame, or the air, which follow in generation. Similarly, the Motion of *Excitation* altogether remains, even when the prime moving power is removed, for a very long time; as in a heated body, when the first Heat; in excited iron, when the magnet; in dough, when the leaven is removed. But Motion of *Impression*, though diffusive and transitive, yet always seems to depend on the prime moving power; so that on its removal or cessation it directly fails and perishes; and so it takes effect in a moment, or at any rate in a short time. Wherefore we are wont to call the Motions of *Assimilation* and *Excitation*, the Motion of *the Generation of Jupiter*, because once generated they continue; but this, the Motion of *the Generation of Saturn*, because when born it is directly devoured and absorbed. This Motion manifests itself in three things; (1) in rays of light; (2) in the production of sound; (3) in communication of Magnetic powers. For if light be removed, colours and all images perish directly; if the first percussion and consequent vibration of a body be removed, the sound perishes almost immediately. For although sounds even in transit are agitated by the wind like waves, yet it must be carefully noted, that the sound does not last so long as the reverberation does. For when a bell is struck, the sound seems to be continued for a considerable length of time; whence any one may easily fall into error, if he thinks that sound floats, and remains in the air through all that time: for this is a great mistake. For that reverberation is not identically the same sound, but a repetition of sounds. And this is shewn by stopping or holding the body struck: thus, if a bell be stopped and held tightly, so as to be immoveable, the sound perishes, and there is no reverberation: this is the case in strings; if, after being first struck, the string is touched with the finger, as in the Harp, or with a quill, as in the Harpsichord, the reverberation immediately ceases. If the Magnet is removed, the iron falls directly. The Moon, however, cannot be removed from the sea, nor the earth from a heavy body as it falls; and so no experiment can be tried on these; but the case is the same.

xiv. Let the fourteenth be the Motion of *Configuration* or *Position;* by which bodies seem to seek, not coition or separation, but *Position*, collocation, and *Configuration* with other bodies. This Motion is very hidden, and has not been well looked into. And in some case it seems almost without cause; although in very truth (as we believe) it is not so. For if it be asked, why the sky revolves from East to West, rather than from West to East, or why it turns round Poles placed near the Bears, rather than round Orion, or some other part of the sky; to ask such a question seems a kind of madness, as these things ought rather to be received on experience as positive. There are, indeed, some things ultimate and incausable; but this does not seem to be one of them. For we think it arises from a sort of Harmony and Sympathy of the world, which as yet has not come under men's observation. But if the Motion of the earth from West to East be assumed, still the same questions remain; for it too must move round certain Poles: and why should those Poles be placed where they are, rather than any where else? The polarity, direction and dip of the Needle also come under this head. Also in bodies, whether natural or artificial, especially solids rather than fluids, there is found to be a certain collocation and position of parts, and as it were hair, or fibres, which ought to be diligently investigated: since without the discovery of these, those bodies cannot be conveniently treated of or governed. The circulation in liquids, by which, when compressed, they raise the several parts of themselves (before they can free themselves) so as to equalise the pressure, we more correctly assign to the Motion of *Liberty*.

xv. Let the fifteenth be Motion of *Transit*, or *according to Passage;* by which the virtues of bodies are more or less hindered, or carried on by their media, according to the nature of the bodies, their active virtues, and also of the medium. For one medium is adapted for Light, another for Sound, another for Heat and Cold, another for Magnetic Virtues, and so on respectively.

xvi. Let the sixteenth be the *Royal* or *Political* Motion, as we term it; by which the dominant and ruling parts of any body curb, tame, subdue, regulate, the other parts, and compel them to unite, separate, stand, move, collect, not as they wish, but according to order, and as conduces to the well-being of the governing part; so that there is a kind of *Reign* and *Polity* which the ruling part exercises over the subject. This Motion is most conspicuous in the spirits of animals, and (so long as it flourishes) it tempers all the Motions of the remaining parts. It is found, too, in other bodies in a lower degree; as has been said of blood and urine, which do not dissolve, until the spirit which used to mingle and restrain their parts, is ejected or stifled. Nor is this motion at all peculiar to spirits, although in most bodies spirit predominates, on account of its swiftness and penetrative power: for in more condensed bodies, not filled with a lively and vigorous spirit (such as is in quicksilver or vitriol), the heavier particles rule, so that, unless this curb and yoke be shaken off by some Art, one has but little hope of any fresh transformation of bodies of this kind. And let no one think that we have forgotten our subject, because we now make mention of *Predominance* among the classes of Motions, while the whole series and arrangement of Motions has the sole object of enabling us to investigate their *Predominance* the better by means of these *Instances of the Struggle.* For in describing this *Royal* Motion, we do not treat of the *Predominance* of Motions or Virtues, but of parts in bodies. For this is that kind of *Predominance* which constitutes this particular Class of Motion.

xvii. Let the seventeenth be the *Spontaneous* Motion of *Rotation;* by which bodies rejoicing in Motion, and favourably placed, enjoy their Nature, and pursue themselves and nothing else: and seem to seek their own embrace. For bodies seem either to move without limit; or to rest; or to move towards a limit, in which they may either rotate or rest, according to their Nature. And those things which are favourably placed, if they love Motion, move in circles: an eternal and infinite Motion. Those which are favourably placed, and hate Motion, rest. Those which are not favourably placed move in a right line (as in the shortest path) to unite with congenial bodies. This Motion of *Rotation* admits of nine differences; (1) As to the centre round which bodies move; (2) As to the Poles on which they move; (3) As to their Orbit relatively to their distance from the centre; (4) As to the Velocity, or greater or less speed of their rotation; (5) As to the direction of their Motion, whether from East to West, or from West to East; (6) As to their declination from the perfect circle by spirals more or less distant from their centre; (7) As to their declination from the perfect circle by spirals more or less distant from their Poles; (8) As to the greater or less distance of their successive spirals; (9) and last, As to the variation of the Poles themselves, if they are moveable: a thing which only affects Circular *Rotation*. And this kind of Motion is held by common and ancient opinion to be peculiar to the Heavenly bodies. And yet there is a great contention as to this Motion among both Ancients and Moderns, who have attributed *Rotation* to the earth. But perhaps a far more reasonable controversy is aroused (if only the matter be not utterly beyond the reach of controversy), whether this Motion (granted that the earth is stationary) is limited to the Heavens, or rather descends, and is communicated to air and water. The Motion of *Rotation* in missiles; as in darts, arrows, musket-balls, &c. we entirely refer to the Motion of *Liberty*.

xviii. Let the eighteenth be the Motion of *Trepidation*, in which (as understood by Astronomers) we do not much believe. But in our serious and general search after the desires of natural bodies, this Motion occurs, and seems to deserve to be formed into a distinct class. It is the Motion as of an eternal captivity; i. e. when bodies not altogether favourably placed according to their Nature, and yet not altogether ill placed, are continually agitated, and restless, neither contented with their condition, nor daring to proceed any farther. This kind of Motion is discovered in the heart and pulses of animals; and must of necessity be in all bodies which remain in so doubtful a state between comfort and discomfort, that they are moved aside in trying to free themselves, then again suffer repulses, and yet again continue to make the attempt.

xix. Let the nineteenth and last be that Motion which the name of Motion scarcely suits, and yet which is clearly such. This we may call Motion of *Repose*, or, of *Abhorrence of Motion*. By this it is that the earth stands through its mass, as the extremes move to the mean, not to an imaginary centre, but to union. Through this desire, too, all things, when much condensed, abhor Motion; and their only desire is not to move; and although they be plucked and provoked to Motion in a thousand ways, yet, so far as they can, they preserve their own Nature. If they are compelled to move, yet they seem always to seek to recover their own quiet and state, and not to move any more. And to this end they certainly prove themselves agile, and seek it with swiftness and rapidity enough, as though weary and impatient of all delay. But of this desire we have but a partial representation, as here on earth, through the digesting and concocting influence of the Heavenly bodies, all tangible bodies are not only not condensed to the utmost, but are even mingled with some amount of spirit.

And so we have now set forth the species or simple elements of Motions, Appetites, and Active Virtues, which are in their own Nature the most universal. Nor is it a small part of Natural Science that has been sketched out under them. Yet we do not deny that there may perchance be other species to be added, and that these same divisions of ours may have to be transferred to suit the truer veins of things; and finally that they may be reduced to a smaller number. Nor do we understand by this any abstract divisions; as if any one were to say, that bodies desire the preservation, or the exaltation, or the propagation, or the fruition of their own Nature: or, that Motions of things tend to preservation and good, either of the universe, (as that of *Resistance*, and that of *Connexion*); or of greater wholes, (as that of *greater Congregation*, *Rotation*, and *Abhorrence of Motion*;) or of special forms, (as the rest of them). For granted that these are true, yet unless they are limited in material and fabric according to true lines, they are speculative, and of but little use. Meanwhile they will suffice, and be of good use in weighing the *Predominances* of Virtues, and in investigating *Instances of the Struggle;* our present object.

For of these Motions which we have set forth, some are entirely invincible; some more powerful than others, binding, curbing, arranging them; some extend farther than others; some are more immediate and swift; some strengthen, cherish, augment, and expedite others.

The Motion of *Resistance* is quite adamantine and invincible. Whether that of *Connexion* is so, we still doubt: for we cannot affirm for certain, whether there is a Vacuum possible, either entire, or partial. Of one thing we are sure; that the reason for which Leucippus and Democritus introduced a Vacuum (viz. that without it the same bodies could not embrace and fill larger and smaller spaces) is a false one. For there is clearly a *Folding of Matter*, which folds and unfolds itself in space between certain limits, without the interposition of a Vacuum: nor is there two thousand times more of Vacuum (as under this hypothesis ought to be the case) in air than in gold. This is shewn quite sufficiently in the most powerful Virtues of pneumatic bodies, (which otherwise would float in a Vacuum like small dust) and by many other proofs. The other kinds of Motion rule and are ruled, each according to the proportion of its vigour, quantity, excitement, ejection, sometimes of the helps, or of the hindrances it meets with.

For example; some armed magnets hold and support iron sixty times their own weight; so far does the Motion of *Lesser Congregation* rule over that of *Greater;* if the weight be heavier, the magnet gives way. A lever of certain strength will raise a certain weight; so far does the Motion of *Liberty* rule over that of *Greater Congregation;* if the weight be greater, it gives way. Stretched leather, up to a certain tension, does not break; so far does the Motion of *Continuation* rule over that of *Tension:* but if the tension be increased, the leather breaks, and the Motion of Continuation gives way. Water flows through a chink of a certain width; so far does the Motion of *Greater Congregation* rule over that of *Continuation;* but if the chink be smaller, it gives way, and the Motion of *Continuation* is victorious. If powdered sulphur and a ball be put into a musket, and fire be applied, the ball is not discharged; for here the Motion of *Greater Congregation* conquers the Motion of *Matter* (ὕλης). But if gunpowder be used, the Motion of *Matter* in the sulphur is victorious, being aided by the Motions of *Matter* and *Avoidance* in the nitre. And so of the rest. For the *Instances of the Struggle* (which mark *Predominance* of Virtues, and according to what proportions and plan they predominate or succumb) are to be gathered from every quarter with keen and sedulous diligence.

The modes, too, and methods of this yielding of Motions are to be diligently investigated. That is, whether they cease entirely, or rather struggle continually, but are bound down. For in bodies on the earth there is no true rest, either in their wholes or their parts; but only apparently so. And that apparent rest is caused either by *Equilibrium;* or by absolute *Predominance* of Motions. By *Equilibrium,* as in balances which remain still if the weights be equal. By *Predominance,* as in perforated water jars, in which the water rests, and is detained from falling by the Motion of *Connexion.* Yet it is to be noted (as we said) how far those yielding Motions struggle. For if any one is held down on the ground in a struggle, with his arms and legs bound, or otherwise confined, he will still try to rise with all his force, though he may not be successful. Moreover, the condition of this matter (viz. whether the yielding Motion is annihilated by the *Predominance;* or rather, the struggle is continued, though not seen) though it is hidden in conflicts, will perchance appear in concurrences. For example: try whether a musket at its utmost range in a straight line, or (as they call it) point-blank, strikes with less force when aimed upwards, when the Motion of the projection is simple, than when aimed downwards, when the Motion of gravity concurs with that of projection.

The Rules of *Predominances* which we fall in with must be collected. As the more common the good thing desired, the stronger the Motion: as that of *Connexion,* which regards the intercourse of the Universe, is stronger than that of gravity, which regards the intercourse of heavy bodies only. Also, that the desires of private good do not for the most part prevail against those of more public good; except where the quantities are small. Would that it were so in civil matters!

49. Twenty-fifth among Prerogative Instances we will place *Intimating Instances;* those, in fact, which intimate and mark out what is advantageous to man. For Power and Knowledge by themselves exalt, but do not bless the race of Man. And so from all things those are to be culled which conduce most to the uses of life. But the more proper place for speaking of these will be when we treat of *Deductions to Practice:* farthermore, in the very work of *Interpretation* in each subject we always assign a place for a *Human* or *Optative Chart.* For to ask and to choose not inaptly is also a part of Science.

50. Twenty-sixth among Prerogative Instances we will place *Instances of Many Uses.* These are such as pertain to various subjects and frequently occur; and so spare much work and many fresh trials. The right place for speaking about instruments and apparatus will be when we treat of *Deductions to Practice,* and *Methods of Experimenting.* Farthermore, whatever is already known, and has come into use, will be described in the particular histories of each Art. For the present we will subjoin some general cases of them as examples only of *Many Uses.*

Man, then, acts upon natural bodies, (besides simple application and removal of them,) in seven chief ways. (1) By excluding those which hinder or disturb; (2) by compressing, extending, agitating, &c.

bodies; (3) by Heat and Cold; (4) by delay in a convenient place; (5) by curb and direction of motion; (6) by special sympathies; (7) by seasonable and due alternation, and series and succession of them all, or at least of some of them.

i. As to the first, then; the common air, which is present everywhere, and forces its way in, and the rays of Heavenly bodies are very disturbing things. Whatever, then, tends to exclude these may be fairly esteemed as an *Instance of Many Uses*. To this, then, belongs the substance and thickness of vessels in which bodies prepared for action are laid up. Such, too, would be careful methods of making vessels air-tight by consolidation, and the *Lutum Sapientiæ* of the Chemists. The exclusion of air by means of liquids on the surface is a most useful thing; as when they pour oil over wine or the juice of herbs, which by expanding on the top like a cover preserves them excellently from damage of the air. Nor are powders a bad thing; for these, although they contain some air mixed up with them, do yet repel the power of the collected and circumambient air: as occurs in preserving grapes and other fruits in sand or flour. Wax too, honey, pitch, and other tenacious substances, are well used to make the exclusion more perfect, and to remove air and the heavenly influences. We have, too, sometimes made experiment by placing a vessel, and some other bodies as well, within quicksilver, which is by far the most dense substance that can be poured round bodies. Farthermore, grottos and subterranean caves are of great use in hindering both sunlight and the free and predatory air; the Northern Germans use such as granaries. The depositing of bodies in water also tends to this end: as I remember I have heard of bottles of wine let down (to be cooled) into a deep well; these were accidentally and carelessly forgotten, and remained there for many years; afterwards they were taken out; and the wine was not only not vapid and lifeless, but far more excellent than before; thanks (it would seem) to the more exquisite mixture of its parts. If the case required that bodies should be sunk under water (as in river-beds or the sea) without themselves touching the water; and without their being enclosed in vessels hermetically sealed, but simply surrounded by air; that vessel may be well used, which is sometimes employed in operations under water upon sunken ships, whereby divers can remain a long time under water, and breathe occasionally by turns. This instrument is of the following kind. A hollow tub of metal was made and sunk with its mouth parallel to the surface of the water; and so it carried down with it to the bottom of the sea the whole content of air which was in it. It stood (like a tripod) on three legs which were somewhat less than man's stature in height; so that the diver, when out of breath, could put his head into the tub, take a breath, and then go on with his work. And we have heard that there has been invented a sort of boat or vessel which can carry men under water for a while. Any bodies, then, can be easily hung up in such a vessel as we have described: and for this cause we have noticed the experiment.

There is, too, another use of the careful and thorough closing up of bodies: namely, that not only is the external air hindered from approaching (as has been said above), but the exit of the spirit of the body, by which internal operations are carried on, is prevented. For he who acts on natural bodies must be certain about their total quantities; viz. be certain that nothing has evaporated or escaped. For great alterations take place in bodies when, Nature forbidding annihilation, Art also forbids the loss or evaporation of any part. As to this matter a false notion prevails (if it were true, one must almost despair of being able to preserve a fixed quantity without diminution), viz. that the spirits of bodies and air rarified to a great extent cannot be retained in any vessels, as they escape through their finer pores. And men have been led into this opinion by those vulgar experiments of a cup inverted over water with a candle or piece of lighted paper in it, by which the water is drawn upwards; and similarly by those cupping glasses which when heated over flame draw up the flesh. Men think that in both these cases the rarified air is emitted, and so the quantity diminished; and so that the water or flesh rise through Motion of *Connexion*. This, however, is utterly false. For the air is not lessened in *quantity*, but contracted in extent; nor does this Motion of succession of the water begin before the flame is extinguished or the air cooled;—wherefore Physicians, that their cupping glasses may draw the better, place wet cold sponges upon them. And so there is no reason why a man should be much afraid of the easy exit of air or spirits. For although it is true that even the most solid bodies have their pores, yet air and spirit do not readily permit themselves to be diminished by such subtle means; just as water, too, refuses to ooze through a very small chink.

ii. As to the second of the seven aforesaid methods it must first be noticed that Compression and violent actions of the kind have a most potent effect on motion in space; and other motions of this sort; (as is seen in machines and missiles;) and even destroy organic bodies and those virtues which consist entirely in motion. For all life, and all flame, too, and ignition, are destroyed by Compression; as, too, every machine is injured and deranged by the same. It also destroys virtues which consist in position and a somewhat rough dissimilarity of parts; as in colours (for the same flower when whole and when bruised has a different colour, and so, too, in amber whole and powdered), and also in tastes (for an unripe pear and one pressed and ripened have different tastes—it grows decidedly sweeter). But this kind of violence does not much affect the more noble transformations and alterations of similar bodies; because bodies do not acquire by them any new constant and quiescent consistency, but only one which is transitory and struggles always to restore and free itself. But it would not be out of our way to make some rather careful experiments on this matter; to see, in fact, whether the condensation or rarefaction of some very similar body (like air, water, oil, &c.), both of them alike affected by violence, can become constant and fixed, and as it were changed into another Nature. This must first be tried by simple delay; then by assistance and sympathies. And this might have been easily done (had it but occurred to us) when we condensed water (as we have mentioned elsewhere) by hammering and pressure, before it burst out. For we ought to have left the sphere with its sides flattened for some days, and then finally to have drawn forth the water; and then have tried whether it would immediately occupy the same space that it did before condensation. If it did not do so directly, or at any rate in a short time, the condensation would have seemed to become constant; if not, it would have appeared that restitution had taken place, and the Compression had been transitory. Something of the kind ought to have been done with the expansion of air in glass-eggs. For they ought after great exhaustion of air to have been suddenly and firmly closed; then to have remained closed for some days; and then finally trial should have been made whether on making a hole the air was drawn in with a hissing sound, or the same quantity was sucked in on immersion, as would have been the case at the beginning if no delay had taken place. For it is probable, or at any rate worth proving, that this might have happened, and might still do so; because length of time has similar effects upon bodies somewhat unlike these. For a stick bent by pressure for some time does not rebound; and this is not owing to any loss of quantity of wood by the delay; for the same is the case with steel springs (if the time be lengthened) which do not suffer evaporation. But if the experiment of simple waiting does not succeed; yet the matter must not be deserted, but other helps must be made use of. For it would be no small gain if fixed and constant Natures could be implanted in bodies by violent means. For in this way air might be turned into water by condensation; and many more like results. For man is lord of violent Motions rather than of any others.

iii. The third of the seven methods is referred to that mighty engine for operation, both of Nature and of Art, Heat and Cold. And here human power clearly halts, as on one foot. For we have the Heat of fire, which is infinitely more powerful and intense than that of the Sun (as it reaches us), and of animals. But Cold is wanting: except such as can be had in winter, or by means of caves, or by surrounding bodies with snow and ice: which, perhaps, may be regarded as corresponding (in degree) to the Heat of the midday Sun in some torrid region, increased by the reflection from mountains and walls: for both Cold and Heat, to this degree, can be endured by animals for a short time. But they are scarcely any thing in comparison with the

Heat of a burning furnace, or of any Cold which may correspond to this degree of Heat. And so all things with us have a tendency towards rarefaction, drying, and waste; hardly anything towards condensation and softening, except by mixtures and spurious methods. Wherefore instances of Cold must be gathered with all diligence: such as seem to be found by exposing bodies upon towers in sharp frost: in subterranean caves; by surrounding bodies with snow and ice, in deep holes excavated for the purpose: by putting them into wells; by covering them with quicksilver and other metals: by immersing them in those waters which change wood into stone: by burying them in the ground; (as the Chinese are said to do in making porcelain, masses of which prepared for the purpose are said to remain buried for forty or fifty years, and to be passed down from father to son like artificial minerals.) Farthermore, the condensations which occur in Nature, by means of Cold, must be in like manner investigated; so that when their causes are learnt, they may be transferred to the Arts. Such are observed in the exudations of marble and other stones: in the vapour upon panes of glass on the inside of windows, at early dawn, after a frosty night: in the origin and gathering of exhalations in subterraneous waters, whence often spring forth fountains: and all such phenomena.

Besides bodies Cold to the touch, there are found to be others which have the powers of Cold and also condense; but these seem to act upon the bodies of animals only, and scarcely beyond. Many such are seen in medicines and plasters. Others condense flesh and tangible parts; as astringents, and even thickening medicaments: others condense spirit, as is best seen in soporifics. Spirits are condensed in two ways by soporific medicaments, or provocatives to sleep; one by calming motion, the other by expelling spirits. For violets, dried rose, lettuces, and such "blessed or benign" medicaments, by their friendly and moderately cooling vapours, invite spirits to unite, and still their quick and unquiet motion. Rosewater, too, applied to the nostrils in fainting fits, restores, and (as it were) nourishes the spirits which had yielded, and had been too relaxed. While opiates, and their kin, put spirits quite to flight, from their malign and unfriendly qualities. And so, if outwardly applied, the spirits immediately flee from that part, and no longer flow readily into it: if taken inwardly, their vapours, rising into the head, put to flight in every direction the spirits in the little cells of the brain, and as the spirits retreat, and have no other part to flee into, they consequently gather and are condensed, and sometimes are quite extinguished and suffocated: although the same opiates, taken in moderation, by a secondary accidental quality (viz. the condensation which follows upon their gathering) strengthen the spirits, render them more robust, and check their useless and excessive motions; for which reason they tend much towards the cure of diseases and the prolongation of life.

The preparation of bodies for receiving Cold is also not to be omitted; as water which has been slightly warmed freezes more rapidly than water quite cold would, &c.

Moreover, as Nature supplies Cold so sparingly, we must do as the Apothecaries do; who, when any simple ingredient cannot be had, take a substitute for it, or a *Quid pro Quo*, as they call it: as aloes for balsam; cassia for cinnamon. Similarly, we must look carefully round us to see if there are any substitutes for Cold; viz. how condensation can be effected in bodies otherwise than by Cold, which effects it as its own peculiar work. Such condensations seem (as far as we as yet know) to be only four. 1. By simple compression; which has but little power to cause permanent density, (for bodies rebound) but yet can perhaps be of some assistance. 2. By contraction of the denser particles of any body, after evaporation or escape of the finer parts, as happens in hardening by fire, and by repeated heating and quenching of metals, and the like. 3. By the coition of the most solid homogeneous parts in any body, which were before dissevered, and mixed with the less solid parts: as in the restoration of sublimated mercury, which in a state of powder occupies a far greater space than simple mercury does: and so in all cleansing of metals from their dross. 4. By sympathies, through application of whatever condenses by latent power of body. These sympathies are rarely seen as yet: a thing not to be marvelled at, since before the discovery of Forms and Structures succeeds, but little can be hoped from the inquiry into sympathies. With regard to animal bodies, it certainly cannot be doubted that there are very many medicines, of internal and external application, which condense by sympathy, as we said just now. But operations of this kind upon inanimate bodies are rare. Both written accounts and hearsay have often told us of a tree in one of the Tercery or Canary Islands, (I do not exactly remember which,) which drips continually; so as to provide the natives in some degree with water. Paracelsus also says that the herb called *Ros solis* is filled with dew at mid-day when the sun is hot, when all other herbs are dry. But we regard both stories as fabulous: were they true, they would be instances of noblest use, and most worthy of careful examination. And that Honey-dew like manna, which people find on oak leaves in May, we do not consider to be made and condensed by any sympathy, or property of oak leaves; but that though it falls equally upon other, it is retained and lasts upon the oak leaves only, because they are close and not porous like most others.

As to Heat: man possesses plentiful means and power, but his observation and inquiry are deficient in some points, and those too the most necessary; however Alchemists may puff themselves. For the effects of fiercer Heat are sought out and observed; while those of gentler (which fall most in with Nature's ways) are not attempted, and so lie hid. And so we see in those furnaces which are much valued, that the spirits of bodies are much exalted, as in strong acids, and some chemical oils; the tangible parts grow hard, and on emission of what is volatile, sometimes are fixed; the homogeneous parts are separated; and even heterogeneous bodies are incorporated and commingled in a coarse way: and particularly the bonds and more subtle structures of compounded bodies are destroyed and confused. But the effects of a gentler Heat ought to be tried and investigated; from thence more subtle mixtures and ordinate structures can be produced and elicited, according to the example of Nature, and imitation of the effects of the Sun: as we have to some extent sketched out in the Aphorism on *Instances of Alliance.* For Nature's effects are produced in far smaller portions, and positions more exquisite and various than those of fire as now shewn. But man may then seem to be really endued with greater power, when the works of Nature can be reproduced in species, perfected in excellence, varied in plenty, by artificial Heat and other powers, and to these one should add, in shorter time. For rust of iron is the result of a long process, while it is turned instantly into *crocus Martis.* So too of verdegris and whitelead. Crystal takes long to form, glass is blown instantly. Stone hardens in long time, bricks are quickly baked, &c. Meanwhile, (our present object,) all different kinds of Heat with their effects respectively, must be carefully and industriously collected, and sought out from all quarters:—that of Heavenly bodies, by their rays, whether direct, reflected, refracted, or gathered into a focus by a lens:—that of lightning, flame, charcoal, fire; of fire of different materials; of fire in open air, or confined, straitened or overflowing; and lastly, affected by the different fabrics of furnaces; roused by bellows, or quiet and not so roused; removed to a greater or a less distance; penetrating different media: of moist Heat, as that of the *Balneum Mariæ;* of dung; of the external and internal Heat of animals; of compressed hay; or of dry Heats, as of cinders, lime, warm sand; in a word, of Heat of every kind, with the degrees of each.

But chiefly we must attempt the inquiry into and discovery of effects and operations of that Heat which gradually, regularly, in fixed times, through fixed distances and delays, approaches and recedes. For this regular inequality is in truth the Daughter of Heaven, and Mother of production: nor is anything great to be expected from Heat, which is either vehement, headlong, or desultory. For this is most plain even in vegetables. And even in the wombs of animals there is great inequality of Heat, from the motions, sleep, nourishment, and passions of females with young. Lastly; in the matrices of the earth,—those wherein metals and fossils are formed,—this same inequality has place and flourishes. Hence the unskilfulness of some of the reformed Alchemists is the more remarkable—for they think they will gain their end by means of the equable Heat of lamps, and the like, which always burn uniformly. And let this suffice for the operations and effects of Heat. For it is not seasonable for us to go deeply into them, before the Forms of things and Structures of bodies have been farther investigated and brought to light. For when we have settled our models, then it is time to seek, apply, and prepare our instruments.

iv. The fourth mode of action is by Delay, the very Steward and Almoner of Nature. By Delay we mean the leaving of a body to itself for a considerable time, defended meanwhile, and fenced against external force. For internal motions shew themselves, and are carried out, when external and adventitious ones cease. The effects of age are far more subtle than those of fire. For such a clarifying of wine as is accomplished by Delay could not be done by fire; nor are the ashes resulting from combustion so delicate as the resolutions and consumptions of ages. The sudden and precipitate incorporations and mixtures accomplished by fire are also far inferior to those by Delay. While dissimilar and various structures, which try bodies by Delay, (like putrefactions,) are destroyed by fire or strong Heat. And it will not be amiss to notice, that motions of bodies quite confined are somewhat violent. For this confinement impedes the spontaneous motions of the body. And so Delay in an open vessel is more effectual for separations; in one quite closed, for mixtures; in one partially closed, yet so as to admit air, for putrefaction. However, instances of the operations and effects of Delay are diligently to be collected from every quarter.

v. The Regulation of Motion (the fifth method of action) is of no little use. By Regulation of Motion we mean the hindrance, repulsion, admission or direction of the spontaneous Motion of one body, by the intervention of another. This for the most part depends on the figure and position of vessels. The upright cone assists condensation of vapours in Alembics; while the inverted cone helps the refining of sugar in vessels lying flat. Sometimes, too, a curved shape, or one alternately contracting and bulging, and the like, are required. All straining, too, is under this head; as when one body by its intervention opens the way to one part of some other body, but blocks it to another part. Nor is this straining or any other Regulation of Motion caused only from without: but even by one body within another; as when pebbles are put into water to collect its lime; syrups are clarified by white of eggs, which makes the grosser particles cohere, so that they can afterwards be taken off. To this Regulation of Motion, Telesio (foolishly and ignorantly enough) also attributed the shapes of animals, in consequence, forsooth, of the channels and folds of the matrix. He ought to have noticed that the formation is just the same in eggs, which have neither wrinkles nor inequality. But it is a true Regulation of Motion to make figures in moulds and casts.

vi. The effects of Agreements or Aversions (the sixth method) often lie deeply hidden. For occult and specific properties (as they call them), and sympathies, and antipathies, are to a great extent the bane of Philosophy. Much is not to be hoped as to the discovery of the Agreements of things before we have discovered simple Forms and Structures. For Agreement is nothing but mutual symmetry of Forms and Structures.

(1) Now the greater and more universal Agreements of things are not utterly obscure. And so we must begin with them. Their first and chief diversity is this; that some bodies which differ very much in quantity or rarity of matter, still agree in Structure; others, on the contrary, which agree in quantity or rarity of matter, differ in Structure. For it is well noted by Chemists in the triad of their principles, that sulphur and mercury permeate through every thing. (For their views on salt are foolish, brought in so as to comprehend earthy, dry, and fixed bodies.) But certainly in those two there seems to be distinguishable a certain Agreement of Nature in most universal substances. For there is Agreement of sulphur with oil, and fat exhalations; with flame; and perhaps with the masses of the stars. On the other hand, there is Agreement of mercury with water, and watery exhalation; with air; and perhaps with the pure æther between the stars. And yet these two sets of four, or great tribes of things, (each in its order,) differ immeasurably in quantity and density of matter, though they agree greatly in Structure—as they shew themselves in very many cases. While different metals agree nearly in quantity and density, (especially when compared with vegetables, &c.) but differ many ways in Structure; similarly, different vegetables and

animals vary almost infinitely in Structure, but in quantity or density of matter lie within a few degrees of one another.

(2) Next comes the Agreement which is most universal after the above; viz. that of principal bodies and their nourishment; such as the womb and aliments. And so inquiry must be made under what climates, in what soil, at what depths each metal is generated: so too of gems, whether in rocks or among minerals: in what soil each kind of tree, shrub, herb, flourishes most and rejoices: and at the same time what enriching of soil (whether by manure of any kind, or chalk, seashore sand, ashes, &c.) is most advantageous, and which of them is most fit and helpful for each variety of soil. Again; the planting and grafting of trees and plants, with the method of each,—i. e. what plants are best grafted on others, &c., all this depends much on Agreement. In this part the experiment we have just heard of as attempted, viz. of grafting woodland trees, (after the fashions in use for garden trees,) whence leaves and acorns multiply, and the trees have fuller foliage, would not be a bad one to try. Similarly, the aliments of animals are to be noted respectively, each in its kind, and with negatives. For carnivorous animals cannot live on herbs; whence, too, the order of Vegetarians (Folietani), (though the will of man has more power over his body than that of other animals has,) after trial made, (it is said,) almost perished, as a thing not endurable by human Nature. The different

materials of putrefaction, whence animalcula are generated, must also be noted.

(3) The Agreements of principal bodies with their subordinates (those we have noted may be regarded as such) are clear enough. To these can be added the Agreement of senses with their objects. As these are most plain, if well noted and shrewdly discussed, they may cast great light on other and latent Agreements.

(4) But the interior Agreements and Aversions, friendships and strifes of bodies, (we are almost weary of the names of sympathies and antipathies in consequence of men's superstitions and follies,) are almost always falsely attributed, or mingled with fiction, or carelessly handled, and are very rare. For if any one asserts that there is disagreement between the vine and the cauliflower, because the one flourishes less near fields planted with the other; the reason is simple enough;—both plants are succulent, and take much nourishment, and so the one defrauds the other. If any one asserts that there is Agreement and friendship between corn and the cornflower, or the wild poppy, because these hardly ever flourish except in arable land; he ought rather to have asserted that there is disagreement between them, because poppies and the cornflower are produced and created by those juices of the soil which the corn has left and cast off: so that the sowing of corn prepares the ground for their springing up. And the number of false ascriptions of this kind is great. And as to fictitious

cases, they must be utterly driven out. There remains then but a small quantity of those Agreements, which are proved by sure experiment; such are those of the magnet and iron, gold and quicksilver, and the like. In chemical experiments on metals, there are found some more cases worth noticing. But where they most abound (in comparison with their general rarity) is in some medicines, which through their occult (as they call them) and specific properties, are connected with either members, or humours, or diseases, or sometimes individual Natures. Nor are the Agreements between the movements and affections of the Moon and the passions of inferior bodies to be omitted; as they can be gathered and received with severe and honest selection from the experiments of agriculture, navigation, and medicine. The more unusual universal instances of the more secret kinds of Agreement are, the more diligently are they to be investigated by means of tradition, and faithful and trustworthy narrations; only this must be done without any levity or credulity, but with anxious and almost a doubting trust.

(5) There remains the Agreement of bodies in their method of operation, inartificial indeed, but of great use. This is no how to be omitted, but to be investigated with diligent observation. It is the ready or difficult coition or union of bodies by conjunction or simple apposition. For some bodies mingle and become incorporate with one another easily and readily: others hardly and perversely: just as dust mingles best with water;

ashes and lime with oil; and so on. Nor are instances of propension or aversion of bodies so mingling only to be gathered, but also those of their collocation of parts, distribution, and digestion after being mixed; and lastly, of predominance after perfect mixture.

vii. There remains, lastly, the seventh and last of these methods of action: viz. action by Alternating and shifting the former six: till we had well inquired into each of these separately, it would not have been seasonable to adduce examples of this method. Now the knowledge of the series or chain of Alternations of this kind, to be applied to the production of each particular effect, is a thing of great difficulty of acquirement, and of greatest efficacy in operation. And the greatest impatience as to both inquiry and practice of this kind restrains and fills men's minds; whereas it is a kind of "Clue to the Labyrinth" for greater effects. And let this suffice for examples of *Many Uses.*

51. Twenty-seventh and last among Prerogative Instances we will place *Magical Instances.* By this name we call those in which the material or efficient is slight or small in comparison with the magnitude of the effect that follows; so that even though they are common, yet are they almost miraculous, some at first sight, others after more attentive contemplation. These, however, Nature offers but scantily of her own accord;—what she will do when her lap is shaken out, after discovery of Forms, Processes, and Structures, will appear in ages yet to come. Now

these *Magical* effects (so far as we can as yet conjecture) occur in three ways; (1) by multiplication of a body by itself; as in fire, in those poisons termed specific, and in those motions which are strengthened as they pass on from wheel to wheel: (2) by exciting or inviting another body, as in the magnet, which excites innumerable needles, without any loss or diminution of virtue; as too, in yeast, and the like: (3) by anticipation in motion, (which has been already spoken of,) in gunpowder, cannon, and mines: of these the two first require an investigation of Agreements: the third of measure of Motions.

As to whether or not there is any method of changing bodies infinitesimally (*per minima*, as the term is), and of transposing the more subtle Structures of matter (a thing which has relation to every kind of transformation of bodies), so that Art may be enabled in a short time to do what Nature endeavours to do through many windings;—of this as yet we have no certain tokens. Moreover, as in sound and true matters we aspire to final and highest results, so do we ever hate, and, so far as in us lies, expel, all things vain and empty.

52. For the respective Dignities or Prerogatives of Instances let this suffice. It remains that we warn people that in this our *Organon* we treat of *Logic* not *Philosophy*. But as our Logic teaches the Intellect, and instructs it not to grasp at and try to hold abstractions (as common Logic does) with slender tintacks (if one may so speak) of the mind,

but really probes Nature; and finds out the virtues and acts of bodies, and their laws as determined in matter; (so that our Science flows out from the Nature of things as well as from the Nature of the mind;)—no wonder if it is everywhere interspersed and illustrated with contemplations and experiments on Nature, as examples of our Method.

As appears from what has been said, the Prerogative Instances are twenty-seven in number. (1) Solitary Instances; (2) Migrating; (3) Ostensive; (4) Clandestine; (5) Constitutive; (6) Conformable; (7) Singular; (8) Deviating; (9) of the Frontier; (10) of Power; (11) Accompanying and Hostile; (12) Subjunctive; (13) of Alliance; (14) Crucial; (15) of Divorce; (16) of the Door; (17) Citing; (18) of the Way; (19) Supplementary; (20) Probing; (21) of the Measuring Rod; (22) of the Course; (23) Doses of Nature; (24) of the Struggle; (25) Intimating; (26) of Many Uses; (27) Magical.

The application of these Instances, whereby they excel ordinary ones, is generally either concerned with Information, or Practice, or both. As to Information; they aid either the Senses or the Intellect; the Senses, as those five *Instances of the Lamp* do: the Intellect, either by quickening the exclusive process for Form, as the *Solitary Instances* do; or by narrowing and pointing more closely to the affirmative Form, as the *Migrating, Ostensive, Accompanying,* with the *Subjunctive Instances* do: or by exalting the Intellect and leading it to genera and common Natures: and that, too, either immediately, as in the *Clandestine* and *Singular Instances*, and those of *Alliance;* or in the next step to it, as in the *Constitutive;* or in the lowest degree, as in the *Conformable:* or by correcting Intellectual habits, as in the *Deviating:* or by leading it to the mighty Form or fabric of the Universe, as in those of the *Frontier:* or by warning and guarding it from false Forms and causes, as in the *Crucial* and those of *Divorce.* As to Practice; they either point it out, or measure, or raise it. They point it out by shewing either whence one must begin, so as to avoid repetition, as in the *Instances of Power;* or what we should aspire to, if opportunity be granted us, as in the *Intimating Instances.* The four *Mathematical* ones measure; those of *Many Uses* and the *Magical* raise.

Again; we must collect some of these twenty-seven, (as we have said above of some,) from the very outset, without waiting for a particular inquiry into Natures. Of this kind are the *Conformable*, the *Singular*, the *Deviating*, those of the *Frontier*, those of *Power*, those of the *Door*, the *Intimating*, those of *Many Uses*, and the *Magical.* For these either help and remedy the Intellect and the Senses, or furnish Practice generally. Then afterwards the rest are to be gathered, when we make *Tables of Comparison* for the work of the Interpreter in any particular Nature. For these Instances distinguished and gifted with such Prerogative are like the soul among the ordinary Instances for Comparison: and as we said at starting, a few of them are worth a multitude of others. Wherefore, in forming our Tables, they must be investigated most carefully, and arranged. It will be necessary to mention them in what follows; and so a Treatise on them had to be prefixed.

But now we must proceed to the *Helps* and *Rectifications of Induction;* then to *Concretes*, to *Latent Processes* and *Structures*, and other things which we set forth in due order in the Twenty-first Aphorism; in order that at length (like upright and faithful guardians) we may hand over to Man his fortunes, after the emancipation and increase of his Intellect: from which must necessarily follow an improvement of his state, and widening of his power over Nature. For Man through the Fall lost both his state of innocence and his lordship over the created world. Both these losses can, even in this life, be partially repaired; the former by Religion and Faith, the latter by Arts and Sciences. For Creation did not by the curse become utterly and thoroughly rebellious: but in virtue of the Decree, "In the sweat of thy brow shalt thou eat bread," by divers labours (but assuredly not by disputation or idle magical ceremonies) she is, to a certain extent, at last compelled to provide Bread to Man, that is, to supply the needs of Human Life.

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